FINAL REPORT

VOLUME 2 of 2 - APPENDICES

A Study of Toxic Emissions from a Coal-Fired Power Plant - Niles Station Boiler No. 2

Contract DE-AC22-93PC93251

To

U.S. Department of Energy

Pittsburgh Energy Technology Center

June 1994

Battelle
. . . Putting Technology To Work

FINAL REPORT

VOLUME 2 of 2 - APPENDICES

on

A STUDY OF TOXIC EMISSIONS FROM A COAL-FIRED POWER PLANT - NILES STATION BOILER NO. 2

Contract No. DE-AC22-93PC93251

Prepared for

DEPARTMENT OF ENERGY
PITTSBURGH ENERGY TECHNOLOGY CENTER

by

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June 1994

VOLUME 2 - APPENDICES

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APPENDIX A

<u>PROCESS DATA LOG SHEETS FROM NILES BOILER NO. 2</u>

TABLE 5-26. PROCESS DATA LOG NO. 1: POWER PLANT CONTROL ROOM BOILER PROCESS DATA
(Record data hourly)

Date: 07-26-93.

Time	Initials of person Recording Data	Load, MW	1A Furnace Outlet Oxygen, percent	Steam temp., F		6A Drum Steam Pres., psig	1A Throttle Steam Flow, klb/hr
				6B SH Outlet	6A 6B RH Outlet		
0700	JP	117	1.80	1000	978	1536	882
0800	J.P.T.	117	1.47	1000	979	1538	881.36
0900	J.P.T.	117	1.31	999	981	1535	881.75
1000	J.P.T.	117	1.56	1000	981	1534	872.83
1100	J.P.T.	117	1.45	1000	979	1537	873.39
1200	J.P.T.	116	1.21	1001	977	1535	873.56
1300	J.P.T.	116	1.18	1000	977	1535	875.47
1400	J.P.T.	117	1.23	1001	982	1535	877.16
1500	J.P.T.	117	1.29	1000	982	1535	879.27
1600	W.P.R	117	1.54	1000	985	1537	880.27
1700	WP.R	117	1.28	1000	987	1537	877.78
1800	WPR	117	1.34	1000	984	1536	876.73
1900	WPR	117	1.25	999	934	1536	881.25
2000	WPR	117	1.41	1000	984	1535	878.13
2100	WPR	117	1.33	1001	981	1533	876.78

1100 RAISED O_2 75% to 78%

Project Engineer Review RJB 10/5/93
Initials/Date

TABLE 5-27. PROCESS DATA LOG NO. 2: POWER PLANT CONTROL ROOM EMISSIONS DATA
(Record data hourly)

Date: 07-26-93.

Time	Initials of Person Recording Data	Total Coal 6A 5A Flow, klb/hr	Stack 3H SO2, ppm	Stack 3H NOx, ppm	Stack Opacity, percent
0700	JP	90.0	2.16	1.27	3.1
0800	J.P.T.	90.8	2.08	1.33	3.1
0900	J.P.T.	90.9	2.14	1.30	3.1
1000	J.P.T.	90.8	2.23	1.27	3.1
1100	J.P.T.	88.9	2.06	1.29	3.1
1200	J.P.T.	89.2	2.05	1.25	3.1
1300	J.P.T.	89.8	2.31	1.26	3.1
1400	J.P.T.	89.8	2.23	1.26	3.1
1500	J.P.T.	90.0	2.25	1.28	3.1
1600	WPR	90.1	2.27	1.32	3.0
1700	WPR	88.4	2.19	1.39	3.0
1800	WPR	88.7	2.23	1.39	3.0
1900	WPR	88.9	2.25	1.35	3.0
2000	WPR	88.6	2.27	1.33	2.6
2100	WPR	89.0	2.20	1.40	2.6

Project Engineer Review RJB 10/5/93
Initials/Date

TABLE 5-28. PROCESS DATA LOG NO. 3: ESP DATA
(Record data every two hours)

Date: 7/26/93

Time	Initials of Person Recording Data	Field	Bus	Primary Side		Secondary Side	
				Voltage, V	Current, amps	Voltage, kv	Current, ma
1000	[illegible]	1	A-B	out	of	service (Tripped)	
		2	A	200	48	[illegible]	120
		2	B	245	70	[illegible]	[illegible]
		3	A	250	[illegible]	[illegible]	[illegible]
		3	B	250	110	[illegible]	300
		4	A	off			
		4	B	off			
		5	A	275	135	48	500
		5	B	275	145	47	550
1200	[illegible]	1	A-B	out	of	service (Tripped)	
		2	A	[illegible]	43	[illegible]	[illegible]
		2	B	250	70	[illegible]	[illegible]
		3	A	[illegible]	[illegible]	[illegible]	[illegible]
		3	B	[illegible]	[illegible]	[illegible]	[illegible]
		4	A	off			
		4	B	off			
		5	A	[illegible]	[illegible]	[illegible]	[illegible]
		5	B	[illegible]	[illegible]	[illegible]	[illegible]

Project Engineer Review RBS 10/5/93
Initials/Date

TABLE 5-28. PROCESS DATA LOG NO. 3: ESP DATA
(Record data every two hours)

Date: 7/26/93

Time	Initials of Person Recording Data	Field	Bus	Primary Side		Secondary Side	
				Voltage, V	Current, amps	Voltage, kv	Current, ma
1400	[illegible]	1	A-B	out [illegible]	[illegible]	[illegible]	[illegible]
		2	A	[illegible]	[illegible]0	[illegible]	[illegible]
		2	B	[illegible]	70	[illegible]	[illegible]
		3	A	[illegible]	[illegible]		
		3	B	[illegible]	[illegible]	[illegible]	[illegible]
		4	A	[illegible]			
		4	B	[illegible]			
		5	A	[illegible]	[illegible]	[illegible]	[illegible]
		5	B	[illegible]	[illegible]	[illegible]	[illegible]
1600	[illegible]	1	A-B	[illegible]	[illegible]	[illegible]	[illegible]
		2	A	190	[illegible]	[illegible]	100
		2	B	260	70	[illegible]	[illegible]
		3	A	[illegible]	[illegible]	[illegible]	[illegible]
		3	B	[illegible]	[illegible]		[illegible]
		4	A	[illegible]			
		4	B	[illegible]			
		5	A	[illegible]	[illegible]	[illegible]	[illegible]
		5	B	275	[illegible]	48	550

Project Engineer Review [illegible] 10/5/93
Initials/Date

TABLE 5-28. PROCESS DATA LOG NO. 3: ESP DATA
(Record data every two hours)

Date: 7/26/93

Time	Initials of Person Recording Data	Field	Bus	Primary Side		Secondary Side	
				Voltage, V	Current, amps	Voltage, kv	Current, ma
1800		1	A-B	out of	service	(tagged)	
		2	A	175	50	4[illegible]	100
		2	B	260	70	-	220
		3	A	260	90	[illegible]	[illegible]
		3	B	260	105	[illegible]	300
		4	A	off			
		4	B	off			
		5	A	275	140	48	[illegible]
		5	B	280	165	[illegible]	[illegible]
2000		1	A-B	out of	serv.	(tagged)	
		2	A	225	48	47	120
		2	B	270	70	54	220
		3	A	260	90	[illegible]	275
		3	B	270	105	[illegible]	300
		4	A	[illegible]			
		4	B	[illegible]			
		5	A	[illegible]	[illegible]	48	500
		5	B	[illegible]	[illegible]	[illegible]	550

Project Engineer Review RSB 10/5/93
Initials/Date

TABLF 5-26. PROCESS DATA LOG NO. 1: POWER PLANT CONTROL ROOM
BOILER PROCESS DATA
(Record data hourly)

Date: 7/27/93

Time	Initials of person Recording Data	Load, MW	Furnace (1A) Outlet Oxygen, percent	Steam temp., F		Drum (6A) Steam Pres., psig	Throttle (1A) Steam Flow, klb/hr
				SH Outlet (6B)	RH Outlet (6A 6B)		
0700	[illegible]	116	1.72	1000	983	1537	875.14
0800	RDD	117.0	1.44	1000	980	1534	874.80
0900	RDD	116.7	1.61	1001	979	1534	875.30
1000	RDD	116.5	1.70	1000	981	1535	876.55
1100	RDD	116.3	1.64	1000	983	1534	877.20
1200	RDD	116.7	1.62	1000	984	1535	876.77
1300	RDD	117.0	1.40	1000	987	1537	879.63
1400	RDD	116.5	1.34	1000	985	1534	878.69
1500	RDD	116.5	1.46	1000	985	1533	874.88
1600	WPR	116.5	1.74	1000	987	1535	878.38
1700	WPR	116.7	1.75	1000	989	1533	878.30
1800	WPR	116.3	1.55	1000	987	1532	877.05
1900	WPR	116.7	2.19	1000	990	1535	874.88
2000	WPR	116.7	1.81	1000	990	1533	875.41

Project Engineer Review RJB 10/5/93
Initials/Date

TABLE 5-27. PROCESS DATA LOG NO. 2: POWER PLANT CONTROL ROOM EMISSIONS DATA

(Record data hourly)

6A 3A 3H 3H Date: 7/27/93

Time	Initials of Person Recording Data	Total Coal Flow, klb/hr	Stack SO2, ppm	Stack NOx, ppm	Stack Opacity, percent
0700	TEm	89.36	2.13	1.42	3.1
0800	RDD	89.0	2.14	1.41	3.1
0900	RDD	89.3	2.19	1.33	3.09
1000	RDD	90.3	2.23	1.36	3.09
1100	RDD	90.4	2.27	1.37	3.10
1200	RDD	89.7	2.23	1.36	3.10
1300	RDD	89.8	2.59	1.41	3.10
1400	RDD	90.5	2.49	1.38	3.10
1500	RDD	91.3	2.70	1.45	3.5
1600	WPR	92.4	2.78	1.42	3.0
1700	WPR	92.9	2.73	1.41	3.1
1800	WPR	92.8	2.76	1.36	3.0
1900	WPR	93.2	2.78	1.36	3.0
2000	WPR	93.5	2.63	1.33	2.6

Project Engineer Review RSS 10/5/93
Initials/Date

TABLE 5-28. PROCESS DATA LOG NO. 3: ESP DATA
(Record data every two hours)

Date: 7/27/93

Time	Initials of Person Recording Data	Field	Bus	Primary Side		Secondary Side	
				Voltage, V	Current, amps	Voltage, kv	Current, ma
0900	[illegible]	1	A-B	tagged out			
		2	A	150	38	40	100
		2	B	250	70	48	220
		3	A	260	90	44	275
		3	B	260	110	48	300
		4	A	off			
		4	B	off			
		5	A	275	135	48	500
		5	B	280	145	48	550
1100	[illegible]	1	A-B	tagged out			
		2	A	215	40	50	120
		2	B	250	70	50	220
		3	A	[illegible]	90	48	275
		3	B	-60	120	48	300
		4	A	off	~~275~~	~~135~~	
		4	B	off			
		5	A	275	135	48	500
		5	B	280	145	48	550

Project Engineer Review RSS 10/5/93
Initials/Date

TABLE 5-28. PROCESS DATA LOG NO. 3: ESP DATA
(Record data every two hours)

Date: 7/27/93

Time	Initials of Person Recording Data	Field	Bus	Primary Side		Secondary Side	
				Voltage, V	Current, amps	Voltage, kv	Current, ma
1300	[illegible]	1	A-B	←	tagged	out	→
		2	A	200	50	46	120
		2	B	250	70	48	220
		3	A	240	90	48	275
		3	B	260	110	48	300
		4	A	off	→		
		4	B	off	→		
		5	A	275	135	48	500
		5	B	280	145	48	550
1500	[illegible]	1	A-B	←	tagged	out	→
		2	A	160	40	44	100
		2	B	260	70	50	220
		3	A	270	90	48	275
		3	B	260	105	48	300
		4	A	off	→		
		4	B	off	→		
		5	A	[illegible]	[illegible]	[illegible]	[illegible]
		5	B	[illegible]	145	48	550

Project Engineer Review REB 10/5/93
Initials/Date

TABLE 5-28. PROCESS DATA LOG NO. 3: ESP DATA
(Record data every two hours)

Date: 7/27/92

Time	Initials of Person Recording Data	Field	Bus	Primary Side		Secondary Side	
				Voltage, V	Current, amps	Voltage, kv	Current, ma
1700	[illegible]	1	A-B	← tripped		out	→
		2	A	220	56	45	120
		2	B	240	70	43	220
		3	A	260	90	40	275
		3	B	205	105	43	300
		4	A	off	→		
		4	B	off	→		
		5	A	275	125	45	500
		5	B	290	145	47	550
1900		1	A-B	← tripped		out	→
		2	A	160	40	42	100
		2	B	250	70	46	220
		3	A	260	90	48	275
		3	B	260	105	49	300
		4	A	off	→		
		4	B	off	→		
		5	A	280	135	4[illegible]	500
		5	B	290	145	42	550

Project Engineer Review RES 10/5/93
Initials/Date

TABLE 5-26. PROCESS DATA LOG NO. 1: POWER PLANT CONTROL ROOM
BOILER PROCESS DATA
(Record data hourly)

Date: 7/28/93

Time	Initials of person Recording Data	Load, MW	Furnace Outlet Oxygen, percent (1A)	Steam temp., F (6B / 6A 6B)		Drum Steam Pres., psig (6A)	Throttle Steam Flow, klb/hr (1A)
				SH Outlet	RH Outlet		
[illegible]	[illegible]m	116	1,82	1002	980	1534	1469
0800	RDD	117.2	1.70	1000	983	1535	853
0900	RDD	116.5	1.72	1000	979	1535	868
1015	RDD	115.8	1.83	1000	981	1534	879
1100	RDD	116.5	1.79	1000	985	1535	881
1200	RDD	117.2	1.82	1000	989	1534	892
1300	RDD	117.3	1.66	1001	994	1534	882
1400	RDD	117.6	1.34	1000	986	1535	882
1500	RDD	117.4	1.52	1000	988	1537	884
1600	WPR.	117.9	1.51	999	994	1533	885
1700	WPR	118.1	1.68	1000	995	1535	886

A+ 0930 O_2 meter was calibrated, shear pin 0953-1001

1617 shear pin 2B-012 1621

Project Engineer Review RJB 10/5/93
Initials/Date

TABLE 5-27. PROCESS DATA LOG NO. 2: POWER PLANT CONTROL ROOM EMISSIONS DATA

(Record data hourly)

6A 3A 3H 3A Date: 7/28/93

Time	Initials of Person Recording Data	Total Coal Flow, klb/hr	Stack SO2, ppm	Stack NOx, ppm	Stack Opacity, percent
0700	Em	91.77	2.26	1.35	3.1
0800	RDE	90.9	2.35	1.38	3.10
0900	RDD	91.5	2.63	1.36	3.10
1015	RDD	93.9	2.61	1.32	3.10
1100	RDD	92.4	2.54	1.29	3.09
1200	RDD	93.9	2.49	1.25	3.10
1300	RDE	94.8	2.55	1.31	2.66
1400	RDD	93.6	2.74	1.31	2.66
1500	RDD	92.0	2.56	1.37	2.66
1600	WPR	95.8	2.73	1.35	2.66
1700	WPR	95.9	2.72	1.33	3.0

Project Engineer Review RES 10/5/93
Initials/Date

TABLE 5-28. PROCESS DATA LOG NO. 3: ESP LATA
(Record data every two hours)

Date: 7/28/93

Time	Initials of Person Recording Data	Field	Bus	Primary Side		Secondary Side	
				Voltage, V	Current, amps	Voltage, kv	Current, ma
0900	[illegible]	1	A-B	tagged out			
		2	A	150	50	44	100
		2	B	260	70	49	[illegible]
		3	A	260	90	[illegible]	[illegible]
		3	B	260	105	49	[illegible]
		4	A	off			
		4	B	off			
		5	A	275	135	49	500
		5	B	280	145	49	550
[illegible]	[illegible]	1	A-B	Tagged out			
		2	A	170	50	42	120
		2	B	250	70	49	220
		3	A	260	[illegible]	44	[illegible]
		3	B	260	[illegible]	43	[illegible]
		4	A	off			
		4	B	off			
		5	A	[illegible]	[illegible]	49	500
		5	B	280	145	48	550

Project Engineer Review RSB 10/5/93
Initials/Date

TABLE 5-28. PROCESS DATA LOG NO. 3: ESP DATA

(Record data every two hours)

Date: 7/28/93

Time	Initials of Person Recording Data	Field	Bus	Primary Side		Secondary Side	
				Voltage, V	Current, amps	Voltage, kv	Current, ma
1300	[illegible]	1	A-B	← tagged out →			
		2	A	210	50	45	[illegible]
		2	B	245	70	48	[illegible]
		3	A	260	90	40	[illegible]
		3	B	260	105	[illegible]	[illegible]
		4	A	← off →			
		4	B	← off →			
		5	A	280	[illegible]	48	500
		5	B	[illegible]	[illegible]	[illegible]	550
[illegible]	[illegible]	1	A-B	← tagged out →			
		2	A	200	50	45	100
		2	B	240	70	48	220
		3	A	265	90	[illegible]	[illegible]
		3	B	265	105	[illegible]	[illegible]
		4	A	[illegible]			
		4	B	[illegible]			
		5	A	[illegible]	[illegible]	48	[illegible]
		5	B	280	135	48	[illegible]

Project Engineer Review RBB 10/5/93

Initials/Date

TABLE 5-28. PROCESS DATA LOG NO. 3: ESP DATA
(Record data every two hours)

Date: 7/28/93

Time	Initials of Person Recording Data	Field	Bus	Primary Side		Secondary Side	
				Voltage, V	Current, amps	Voltage, kv	Current, ma
1700	[illegible]	1	A-B	← [illegible]		[illegible]	→
		2	A	225	50	48	120
		2	B	250	70	48	220
		3	A	270	90	50	275
		3	B	265	105	48	300
		4	A	← off	→		
		4	B	← off	→		
		5	A	280	135	49	500
↓	↓	5	B	280	145	[illegible]	[illegible]
		1	A-B				
		2	A				
		2	B				
		3	A				
		3	B				
		4	A				
		4	B				
		5	A				
		5	B				

Project Engineer Review RB 10/5/93
Initials/Date

TABLE 5-26. PROCESS DATA LOG NO. 1: POWER PLANT CONTROL ROOM
BOILER PROCESS DATA
(Record data hourly)

Date: 7/29/93

Time	Initials of person Recording Data	Load, MW	1A Furnace Outlet Oxygen, percent	Steam temp., F 6B SH Outlet	6A 6B RH Outlet	6A Drum Steam Pres., psig	1A Throttle Steam Flow, klb/hr
0700	JEm	116	1.97	1001	983	1531	~~1458~~
0800	GPJ	117	1.82	1000	990	1532	863.88
0900	GPJ	117	1.95	999	993	1534	867.83
1000	GPJ	117	1.96	1001	991	1533	862.36
1100	GPJ	117	1.46	1000	986	1532	865.20
1200	GPJ	117	1.86	1000	989	1533	863.80
1300	GPJ	116	1.42	1001	986	1535	868.06
1400	GPJ	116	1.81	1000	988	1534	865.53
1500	GPJ	116	1.67	1000	986	1534	867.00
1600	HWP	116.7	1.65	1000	988	1535	866.67
1700							
1800							

RJB 10/5/93

TABLE 5-27. PROCESS DATA LOG NO. 2: POWER PLANT CONTROL ROOM EMISSIONS DATA
(Record data hourly)

6A 3A 3H 3H Date: 7/29/93

Time	Initials of Person Recording Data	Total Coal Flow, klb/hr	Stack SO2, ppm	Stack NOx, ppm	Stack Opacity, percent
0700	JEm	92.40	2.58	1.29	3.09
0800	J.P.J.	94.8	2.48	1.33	3.10
0900	J.P.J.	93.8	2.41	1.31	3.1
1000	J.P.J.	96.6	2.44	1.32	3.1
1100	[illegible]	95.0	2.2	1.34	3.1
1200	J.P.J.	95.3	2.33	1.29	3.1
1300	J.P.J.	93.3	2.60	1.31	3.1
1400	J.P.J.	93.9	2.71	1.34	3.1
1500	J.P.J.	93.4	2.57	1.29	3.1
1600	[illegible]	[illegible]	2.58	1.31	3.9
1700					
1800					

Project Engineer Review RS 10/5/93
Initials/Date

TABLE 5-28. PROCESS DATA LOG NO. 3: ESP DATA
(Record data every two hours)

Date: 7/29/93

Time	Initials of Person Recording Data	Field	Bus	Primary Side		Secondary Side	
				Voltage, V	Current, amps	Voltage, kv	Current, ma
0900	[illegible]	1	A-B	tagged out			
		2	A	205	50	44	120
		2	B	225	70	46	220
		3	A	265	90	50	275
		3	B	265	105	49	300
		4	A	off			
		4	B	off			
		5	A	280	135	49	500
		5	B	280	145	48	550
1100	[illegible]	1	A-B	tagged out			
		2	A	210	50	46	120
		2	B	240	70	48	220
		3	A	260	90	49	275
		3	B	265	105	48	300
		4	A	off			
		4	B	off			
		5	A	280	135	49	500
		5	B	280	145	49	550

Project Engineer Review REB 10/5/93
Initials/Date

TABLE 5-28. PROCESS DATA LOG NO. 3: ESP DATA
(Record data every two hours)

Date: 7/29/93

Time	Initials of Person Recording Data	Field	Bus	Primary Side		Secondary Side	
				Voltage, V	Current, amps	Voltage, kv	Current, ma
1300	jwh	1	A-B	tagged		out	
		2	A	220	50	47	220
		2	B	240	70	45	220
		3	A	265	90	50	275
		3	B	265	105	49	300
		4	A	off			
		4	B	off			
		5	A	280	133	49	500
		5	B	290	145	48	550
1500	j.h.	1	A-B		tagged	out	
		2	A	220	50	44	120
		2	B	235	70	46	220
		3	A	260	90	49	250
		3	B	270	105	48	300
		4	A	off			
		4	B	off			
		5	A	280	133	49	500
		5	B	290	145	40	550

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TABLE 5-26. PROCESS DATA LOG NO. 1: POWER PLANT CONTROL ROOM
BOILER PROCESS DATA
(Record data hourly)

Date: 07-30-93

Time	Initials of person Recording Data	Load, MW	Furnace 1A Outlet Oxygen, percent	Steam temp., F 6B SH Outlet	Steam temp., F 6A 6B RH Outlet	Drum 6A Steam Pres., psig	Throttle 1C Steam Flow, klb/hr
0700	JEM	116	1.[illegible]3	1001	973	1535	~~[illegible]~~
0800	J.P.T.	116	1.95	999	980	1534	865.72
0900	J.P.T.	116	2.16	1000	986	1533	864.70
1000	J.P.T.	117	2.14	1000	992	1535	864.22
1100	J.P.J.	117	1.82	1000	993	1533	862.44
1200	J.P.T.	117	2.15	999	993	1534	864.20
1300	J.P.T.	117	1.98	999	991	1531	858.61
1400	J.P.T.	117	2.07	1000	995	1534	862.66
1500	J.P.T.	116	2.17	999	989	1528	862.83
1600							
1700							
1800							

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TABLE 5-27. PROCESS DATA LOG NO. 2: POWER PLANT CONTROL ROOM EMISSIONS DATA
(Record data hourly)

6A 3A 3H 3H Date: 07-30-93

Time	Initials of Person Recording Data	Total Coal Flow, klb/hr	Stack SO2, ppm	Stack NOx, ppm	Stack Opacity, percent
0700	TEm	90.10	2.65	1.33	3.10
0800	J.P.T.	92.1	2.75	1.32	3.1
0900	J.P.T.	94.2	2.63	1.24	3.1
1000	J.P.T.	94.4	2.64	1.28	3.1
1100	J.P.T.	94.8	2.64	1.31	3.1
1200	J.P.T.	94.6	2.65	1.36	3.1
1300	J.P.T.	94.3	2.82	1.38	3.1
1400	J.P.T.	95.2	2.59	1.36	3.1
1500	J.P.T.	93.4	2.61	1.40	3.1
1600					
1700					
1800					

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TABLE 5-28. PROCESS DATA LOG NO. 3: ESP DATA
(Record data every two hours)

Date: 7/30/93

Time	Initials of Person Recording Data	Field	Bus	Primary Side		Secondary Side	
				Voltage, V	Current, amps	Voltage, kv	Current, ma
0900	[illegible]	1	A-B	← Tagged out →			
		2	A	200	48	42	130
		2	B	230	70	45	220
		3	A	260	85	50	275
		3	B	260	105	48	300
		4	A	off →			
		4	B	off →			
		5	A	275	135	49	500
		5	B	280	145	48	550
1100	[illegible]	1	A-B	← tagged out →			
		2	A	200	48	44	130
		2	B	235	70	46	220
		3	A	260	90	49	275
		3	B	260	105	48	300
		4	A	← →			
		4	B	← →			
		5	A	280	135	49	500
		5	B	280	145	48	550

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TABLE 5-28. PROCESS DATA LOG NO. 3: ESP DATA

(Record data every two hours)

Date: 7/30/73

Time	Initials of Person Recording Data	Field	Bus	Primary Side		Secondary Side	
				Voltage, V	Current, amps	Voltage, kv	Current, ma
1300	[illegible]	1	A-B	tagged out			
		2	A	180	50	40	120
		2	B	230	70	44	220
		3	A	260	90	49	275
		3	B	260	105	48	300
		4	A	off			
		4	B	off			
		5	A	280	135	49	500
		5	B	280	145	48	550
1500	[illegible]	1	A-B	Tagged out			
		2	A	220	50	44	130
		2	B	235	70	46	220
		3	A	260	90	44	275
		3	B	260	105	48	300
		4	A	off			
		4	B	off			
		5	A	280	135	49	500
		5	B	290	145	40	550

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TABLE 5-28. PROCESS DATA LOG NO. 3: ESP DATA
(Record data every two hours)

Date: 7/30/93

Time	Initials of Person Recording Data	Field	Bus	Primary Side		Secondary Side	
				Voltage, V	Current, amps	Voltage, kv	Current, ma
1700		1	A-B		tagger	out	
		2	A				
		2	B				
		3	A				
		3	B				
		4	A	off			
		4	B	off			
		5	A				
		5	B				
		1	A-B				
		2	A				
		2	B				
		3	A				
		3	B				
		4	A				
		4	B				
		5	A				
		5	B				

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TABLE 5-26. PROCESS DATA LOG NO. 1: POWER PLANT CONTROL ROOM BOILER PROCESS DATA

(Record data hourly)

Date: 7/31/93

Time	Initials of person Recording Data	Load, MW	Furnace Outlet Oxygen, percent 1A	Steam temp., F 6B	6A 6B	Drum Steam Pres., psig 6A	Throttle Steam Flow, klb/hr 1A
				SH Outlet	RH Outlet		
0700	7Em	115	1.58	1003	966	1533	[illegible]70
0800	WPR	116.7	1.97	1000	977	1533	867.5
0900	WPR	117.6	1.87	1000	983	1536	868.48
1000	WPR	117.2	1.77	1000	985	1535	868.48
1100	WPR	117.0	1.76	999	986	1533	866.34
1200	WPR	117.3	2.06	1000	989	1529	871.03
1300	WPR	118.3	2.01	1000	994	1535	875.31
1400	WPR	116.7	1.87	1000	989	1526	868.61
1500	WPR	118.1	1.97	1000	993	1533	873.75
1600	HP	117.9	1.92	1001	996	1533	868.64

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TABLE 5-27. PROCESS DATA LOG NO. 2: POWER PLANT CONTROL ROOM EMISSIONS DATA
(Record data hourly)

6A 3A 3H 3H Date: 7/31/93

Time	Initials of Person Recording Data	Total Coal Flow, klb/hr	Stack SO2, ppm	Stack NOx, ppm	Stack Opacity, percent
0700	TEM	91.08	2.43	1.21	3.56
0800	WPR	94.70	2.30	1.27	3.10
0900	WPR	95.2	2.35	1.29	3.55
1000	WPR	95.5	2.39	1.31	3.09
1100	WPR	95.5	2.43	1.34	3.10
1200	WPR	97.1	2.43	1.41	3.10
1300	WPR	97.2	2.41	1.46	3.09
1400	WPR	97.6	2.35	1.37	3.10
1500	WPR	98.1	2.34	1.38	3.09
1600	HP	97.6	2.20	1.41	3.10

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TABLE 5-28. PROCESS DATA LOG NO. 3: ESP DATA
(Record data every two hours)

Date: 7/31/93

Time	Initials of Person Recording Data	Field	Bus	Primary Side		Secondary Side	
				Voltage, V	Current, amps	Voltage, kv	Current, ma
0700	kml	1	A-B	← tagged out →			
		2	A	160	50	42	120
		2	B	235	70	46	220
		3	A	265	90	50	275
		3	B	260	110	48	300
		4	A	off →			
		4	B	off →			
		5	A	280	135	49	500
		5	B	290	145	49	550
1100	kml	1	A-B	← tagged out →			
		2	A	200	50	45	120
		2	B	240	70	46	220
		3	A	265	90	50	275
		3	B	265	105	49	300
		4	A	off →			
		4	B	off →			
		5	A	280	135	49	500
		5	B	280	145	49	550

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TABLE 5-28. PROCESS DATA LOG NO. 3: ESP DATA
(Record data every two hours)

Date: 7/31/93

Time	Initials of Person Recording Data	Field	Bus	Primary Side Voltage, V	Primary Side Current, amps	Secondary Side Voltage, kv	Secondary Side Current, ma
1300	jrh	1	A-B	tripped out			
		2	A	220	50	46	120
		2	B	240	70	48	220
		3	A	270	90	52	275
		3	B	270	105	49	300
		4	A	off			
		4	B	off			
		5	A	280	135	49	500
		5	B	280	145	48	550
1500	jrh	1	A-B	tripped out			
		2	A	220	50	46	120
		2	B	240	70	48	220
		3	A	270	90	51	275
		3	B	265	105	49	300
		4	A	off			
		4	B	off			
		5	A	280	135	49	500
		5	B	280	145	48	550

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TABLE 5-28. PROCESS DATA LOG NO. 3: ESP DATA
(Record data every two hours)

Date: 7/31/93

Time	Initials of Person Recording Data	Field	Bus	Primary Side		Secondary Side	
				Voltage, V	Current, amps	Voltage, kv	Current, ma
1600	[illegible]	1	A-B	← tagg out		→	
		2	A	220	50	46	120
		2	B	245	70	47	220
		3	A	270	90	51	275
		3	B	270	105	50	300
		4	A	← off	→		
		4	B	← off	→		
		5	A	280	135	49	500
		5	B	280	145	48	550
		1	A-B				
		2	A				
		2	B				
		3	A				
		3	B				
		4	A				
		4	B				
		5	A				
		5	B				

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APPENDIX B

AUDITING

AUDITING

B-1. Introduction

No audits were conducted at Niles Station during the period of sampling at Boiler No. 2. However, during the previous week (i.e., the week of July 18-24) Battelle and Chester staff conducted six days of solid, liquid, and flue gas sampling at the SNOX process, an Innovative Clean Coal Technology Demonstration Project operating at Boiler No. 2. During that time period, Research Triangle Institute (RTI) conducted technical and performance audits of the field effort. Those audits took place on July 20 and 21, 1993. Because the Boiler No. 2 field effort described in this report followed immediately after that at the SNOX process, the RTI audits are considered to apply to the Boiler No. 2 study as well.

The RTI activities included technical audits, performance audits, and CEM calibrations. Those separate activities are discussed in Sections B-2 through B-4, respectively. The RTI Field Sampling Audit Report for Niles Station is included at the end of this Appendix.

B-2. Technical Audits

The following are responses to specific comments made by RTI; these are organized under the same headings and in the same order as the original comments in the enclosed RTI report.

Findings

(1) There is no intent of assigning all of the probe rinse particulate to any one particle size fraction. This material is considered as a separate component, for example in discussion of particle size distributions in Section 7.3. Given the constraints of flue gas sampling at the ESP inlet, there was no alternative to use of the extractive sampling mode.

(2) The glass cyclones were designed to provide the desired particle size cuts, and to be accommodated within a Method 5 heated box along with the particulate filter. Insufficient time was available before the field study to conduct verification tests, but the flow rates used in the field were appropriate for achieving the desired 10 μm and 5 μm size cuts.

(3) This comment does not apply to Boiler No. 2 sampling.

(4) The Fyrite solutions used by Chester for O_2 measurements at Locations 5a and 5b at Boiler No. 2 were replaced regularly, following this comment from RTI auditing previous to the Boiler No. 2 measurements.

(5) No response needed.

(6) Blank samples were taken of all reagents made up with the deionized water, for blank subtraction.

(7) The impact on data should be minimal, since gas flow/reagent volume ratios were similar with the two sizes of glassware.

(8) The potential for some effect from SO_2 in the flue gas is real, however, it is not clear how "bleaching" of DNPH solution by SO_2 could be greater in the second impinger than in the first. The procedure used was discussed with knowledgeable staff at U.S. EPA prior to the study, and the aldehyde results appear reasonable (see Section 5.7).

(9) This comment refers to the baghouse at the SNOX process, but the same tool was used in collection of ESP ash at Boiler No. 2. The impact on ash composition data is almost certainly negligible, given the ample quantities of ash collected, and the small amount of damage to the sampling device.

(10) This comment is not pertinent to sampling at Boiler No. 2.

<u>Observations</u>

(1) No comment needed.

(2) No comment needed.

(3) This comment refers to an issue that field staff were not qualified to address. To the extent possible, review of analytical data has been conducted in compiling data for this report, and in preparing study data for the PISCES data base format.

Recommendations

(1) This recommendation appears to contradict the comments made by RTI under Findings, Item 5. No critical weighings were conducted in the field, so NIST-traceable weigh checks are unnecessary.

(2) Reagent blanks were analyzed for all sampling methods, and the data shown in this report have been properly corrected. The water itself was not analyzed.

(3) The scope of this study does not include such an investigation. As noted above, guidance from U.S. EPA indicates the method should not be invalidated by elevated SO_2 levels.

(4) The use of such a model would be very prone to error, given the frequently changing configuration of the probe and flexible line combination. No useful information would be obtained from such an effort.

(5) Validation testing such as that suggested is beyond the scope of the present study, though it may be of value in future work. Given that the cyclones were used at only one location having a very high particulate loading, such an effort would have minimal effect on the results of this study.

(6) During sampling at Boiler No. 2, the Fyrite sample solutions were changed regularly to avoid use of aged solutions.

B-3. Performance Evaluation Audits

As indicated in the enclosed RTI Field Sampling Audit Report, RTI performed Performance Evaluation Audits (PEA) by spiking sampling materials with target analytes. Tables B-1, B-2, B-3, and B-4 show the results of the analyses of the spiked samples for metals, PAH, VOST, and aldehydes, respectively. For each spiked sample, the mass of analyte found by Battelle, the mass of analyte spiked into the sample as reported by RTI, and the percent recovery of the spiked analyte are shown. The significance of these results is discussed according to analyte class in the following paragraphs.

Metals

As shown in Table B-1, six of the recoveries for the PEA samples are outside of the range of 70 to 130 percent. Battelle's accuracy requirement for metals was 80 to 120 percent recovery for certified standard materials. Since the PEA samples are not certified standards, and since analyte losses may have occurred during spiking, a wider range for these analyses is considered acceptable.

For the filter samples, mercury and selenium showed lower recoveries than the other three analytes (excluding cadmium in N-18-MUM-721). This result could be due to potential losses of these compounds during the spiking process or during sample handling, preparation, and analysis.

The 55 percent recovery for cadmium in N-18-MUM-721 filter is considered an outlier since cadmium recoveries for all other samples are acceptable.

The 44 percent recovery for selenium in N-18-MUM-721 (solution) is attributed to the low spike level and the anticipated lower analytical accuracy near the detection limit of a method. The detection limit for selenium in prepared H_2O_2 impinger solution was 0.01 mg/L; the detected level in N-18-MUM-721 was 0.07 mg/L. This low selenium recovery is not expected to occur in actual samples because selenium levels in most samples were found at much higher concentrations.

PAH

As shown in Table B-2, recoveries for almost all of the PAH in the PEA samples were between 50 to 150 percent. This accuracy limit was established on this project for recovery of deuterated PAH spiked into samples prior to extraction and is reasonable to use as a limit for the PEA samples.

The low recovery of the volatile PAH naphthalene from spiked filters results principally because this compound was spiked onto blank filters rather than onto particulate matter on filters. Volatile PAH are more stable on particulate matter than on blank filters. Much of the spiked naphthalene was likely lost from the blank filters during sample handling and transporting. Acenaphthylene and acenaphthene are similarly volatile and also showed slightly lower recoveries on the filter PEA samples in comparison to the other PAH. An alternative approach to spiking would be to spike collected filter samples with deuterated PAH. The low recovery for naphthalene on the filter PEA samples is not expected to affect sample results since this volatile PAH would be bound on particulate in actual filter samples and less susceptible to the losses described here.

The recovery (162 percent) for dibenzo(a,h)anthracene from the N-19 filters was higher than 150 percent for one of the four PEA samples. Since all the recoveries for other PAH in this sample were in the acceptable range, this high recovery is probably due to contamination in the field spiking process, or in sample handling, or in the laboratory. However, this high recovery should not affect sample results because dibenzo(a,h)anthracene was not detected in the field blanks and laboratory method blanks.

VOST

For the majority of the VOST compounds (Table B-3), recoveries of the spiked compounds into the PEA samples were within 26 to 160 percent. This accuracy limit was established for recovery of surrogate spikes from VOST samples and is reasonable to use as a limit for PEA samples.

The recoveries for bromomethane were lower than 26 percent in two of the three PEA samples. These low recoveries are attributed to losses due to volatility. It cannot be determined whether these losses may have occurred during the spiking process or during analysis. If losses occurred during analysis, then sample results may have been affected in a similar manner.

The recoveries for trichloroethene were higher than 160 percent for two of the three PEA samples. This high recovery is probably not due to contamination in the field or laboratory since trichloroethene was not detected in actual samples (detection limit of 0.025 μg). It may be due to an error in the amount spiked or inaccurate quantification (i.e., calibration) of trichloroethene in the analysis. However, these two causes would not prevent the detection of trichloroethene in the actual samples; and since trichloroethene was not detected, the high trichloroethene recoveries do not affect sample results.

Vinyl chloride was not detected (ND) in the PEA samples at a detection limit of 0.025 μg. Since the spike levels are well above the detection limit, these results suggest that, like bromomethane, losses of vinyl chloride may have occurred during the spiking process or during analysis.

Methylene chloride results are not reported (NR) for the PEA samples because spurious contamination in VOST blank samples made data for all samples suspect.

Battelle did not analyze 1,3-butadiene, trichlorofluoromethane, or 1,2-dibromomethane as a part of this project so results are not provided for these compounds in the PEA samples.

Aldehydes

The recoveries for formaldehyde spiked into the PEA samples were between 50 to 150 percent as listed in Table B-4. This limit was established on this project for recovery of aldehydes and is reasonable to use as a limit for the PEA samples. These acceptable recoveries suggest that recovery of target aldehydes from actual samples was effective.

B-4. CEM and Sensor Audits

As described in the enclosed RTI report, RTI audited Battelle's paramagnetic O_2 analyzers, Chester Environmental's Fyrite O_2 analyzers, dry gas meters from both groups, and SO_2 and NO_x CEM instruments operated by ABB at the SNOX facility. All but the last are pertinent to the Boiler No. 2 sampling effort. Results of these audits are tabulated in the enclosed RTI report. Battelle's dry gas meter results, noted in the RTI report, were provided to RTI, and to the best of our knowledge agreed within a few percent with the RTI audit.

B-5. Battelle Project Audits

A copy of the findings of the audits conducted by Battelle's Quality Assurance Project Officer is provided as the last part of this appendix.

B-6. Results from Coal Analysis Round Robin

Results from the coal analysis round robin coordinated by Consol, Inc. (Consol) for DOE/PETC are presented in Tables B-5 and B-6 for Samples F and O, respectively, which are the duplicate samples generated from Niles coal provided by Battelle to Consol.

A comparison of the average round robin results for Niles coal from all five laboratories participating in the study, with the results provided in Table 5-6 of Section 5 of this report for Niles boiler feed coal, is provided in Table B-7. In general, the relative percent difference between the average results for detected elements in the boiler feed coal presented in Table 5-6 and the average result obtained for Niles coal (designated Samples F and O) by the five laboratories participating in the round robin study was less than 30 percent. (The relative percent difference values were calculated as the difference between the two dry averages, divided by the mean of the two averages.)

The shaded results in Table B-7 indicate cases where the average round robin result was used in mass balance calculations instead of the result provided in Table 5-6 of this report. For three of the elements, cadmium, molybdenum, and selenium, the round robin result was used to replace a nondetected value reported in Table 5-6 to provide better accuracy.

Antimony and nickel were the only two detected elements with relative percent differences above 30 percent, at 56 percent and 38 percent, respectively. The average antimony result from the round robin result (2.1 μg/g, dry, versus 1.1 μg/g, as received in Table 5-6) was therefore used in the mass balance calculation. The average nickel result from the round robin study (28.2 μg/g, dry, versus 18 μg/g, as received, in Table 5-6) was not used in the mass balance calculations because the percent relative standard deviation associated with nickel in the round robin study was relatively high (average of 33.1 percent), as was the range (76 percent) in comparison to the other elements. This suggested that the round robin result was not more accurate than the result presented in Table 5-6.

TABLE B-1. RESULTS FOR RTI PERFORMANCE EVALUATION AUDITS - METALS

	N-18-MUM-721 Filter			N-19-MUM-721 Filter			N-18-MUM-721 *H2O2 Solution*			N-19-MUM-721 *H2O2 Solution*			N-18-MUM-721 *KMNO4 Solution*			N-19-MUM-721 KMNO4 Solution		
	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery
Arsenic	26.8	30	89	28.3	30	94	23.1	30	77	23.1	30	77	NS	NS	NC	NS	NS	NC
Cadmium	10.9	20	55 *	26.5	30	88	14.4	20	72	30.6	40	77	NS	NS	NC	NS	NS	NC
Lead	13.1	15	87	27.3	30	91	11.88	15	79	7.5	10	75	NS	NS	NC	NS	NS	NC
Mercury	13.4	30	45 *	14	30	47 *	25.2	30	84	NS	NS	NC	24.8	20	124	13.12	10	131 *
Selenium	7.8	10	78	14.2	30	47 *	4.38	10	44 *	35.6	50	71	NS	NS	NC	NS	NS	NC

*Recovery outside of 70 to 130 percent.
NS = Not spiked; NC = Not calculated.

TABLE B-2. RESULTS FOR RTI PERFORMANCE EVALUATION AUDITS - PAH

Compound	N-18-MM5-720 (XAD)			N-19-MM5-720 (XAD)			N-18-MM5-720 (Filter)			N-19-MM5-720 (Filter)		
	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery
Naphthalene	10.80	10.0	108	15.00	20.0	75	0.288	5.0	6 *	0.671	15.0	4 *
Acenaphthylene	18.40	20.0	92	25.90	40.0	65	7.05	10.0	71	19.00	30.0	63
Acenaphthene	8.60	10.0	86	14.20	20.0	71	3.43	5.0	69	9.84	15.0	66
Fluorene	2.08	2.0	104	3.66	4.0	92	1.01	1.0	101	2.85	3.0	95
Phenanthrene	0.958	1.0	96	1.72	2.0	86	0.540	0.5	108	1.45	1.5	97
Anthracene	0.942	1.0	94	1.75	2.0	88	0.467	0.5	93	1.40	1.5	93
Fluoranthene	1.94	2.0	97	3.47	4.0	87	1.01	1.0	101	2.93	3.0	98
Pyrene	0.956	1.0	96	1.72	2.0	86	0.482	0.5	96	1.40	1.5	93
Benz(a)anthracene	1.05	1.0	105	2.08	2.0	104	0.575	0.5	115	2.05	1.5	137
Chrysene	1.09	1.0	109	1.80	2.0	90	0.534	0.5	107	1.88	1.5	125
Benzo(b+k)fluoranthene	3.95	3.0	132	8.40	6.0	140	1.88	1.5	125	4.37	4.5	97
Benzo(a)pyrene	1.16	1.0	116	2.48	2.0	124	0.486	0.5	97	1.64	1.5	109
Indeno(1,2,3-c,d)pyrene	1.03	1.0	103	2.05	2.0	103	0.45	0.5	90	1.83	1.5	122
Dibenzo(a,h)anthracene	2.57	2.0	129	5.79	4.0	145	1.15	1.0	115	4.86	3.0	162 *
Benzo(g,h,i)perylene	1.94	2.0	97	4.23	4.0	106	0.93	1.0	93	3.65	3.0	122

*Recovery outside of 50 to 150 percent.

TABLE B-3. RESULTS FOR RTI PERFORMANCE EVALUATION AUDITS - VOST

Compound	N-20-VOS-721-4 Found (ug)	N-20-VOS-721-4 Spiked (ug)	N-20-VOS-721-4 Percent Recovery	N-20-VOS-721-5 Found (ug)	N-20-VOS-721-5 Spiked (ug)	N-20-VOS-721-5 Percent Recovery	N-20-VOS-721-6 Found (ug)	N-20-VOS-721-6 Spiked (ug)	N-20-VOS-721-6 Percent Recovery
Bromomethane	0.078	0.249	31	0.061	0.248	25 *	0.041	0.252	16 *
Chloroform	0.143	0.174	82	0.160	0.174	92	0.152	0.176	86
1,2-Dichloroethane	0.151	0.147	103	0.097	0.147	66	0.102	0.149	68
1,1,1-Trichloroethane	0.339	0.296	115	0.448	0.295	152	0.410	0.299	137
Carbon tetrachloride	0.221	0.245	90	0.275	0.244	113	0.273	0.247	111
1,2-Dichloropropane	0.566	0.382	148	0.470	0.380	124	0.458	0.385	119
Trichloroethene	0.258	0.206	125	0.384	0.205	187 *	0.363	0.208	175 *
Benzene	0.177	0.127	139	0.154	0.126	122	0.150	0.128	117
Tetrachloroethene	0.361	0.281	128	0.405	0.280	145	0.382	0.284	135
Toluene	0.271	0.302	90	0.302	0.300	101	0.293	0.304	96
Chlorobenzene	0.427	0.353	121	0.444	0.351	126	0.430	0.356	121
Ethylbenzene	0.319	0.306	104	0.320	0.305	105	0.285	0.309	92
Xylenes (Total)	0.138	0.317	44	0.123	0.316	39	0.088	0.320	27
Vinyl chloride	ND	0.0798	NC	ND	0.0794	NC	ND	0.0805	NC
Methylene chloride	NR	0.225	NC	NR	0.224	NC	NR	0.227	NC
1,3-Butadiene	NA	0.052	NC	NA	0.0514	NC	NA	0.0520	NC
Trichlorofluoromethane	NA	0.432	NC	NA	0.430	NC	NA	0.436	NC
1,2-Dibromomethane	NA	0.597	NC	NA	0.595	NC	NA	0.603	NC

*Recovery outside of 26 to 160 percent.
ND = Not detected (detection limit of 0.025 ug); NR = Not reported; NA = Not analyzed.

TABLE B-4. RESULTS FOR RTI PERFORMANCE EVALUATION AUDITS - ALDEHYDE

Compound	N-ALD-DUP-721 (Imp. 2)			N-ALD-DUP-721 (Imp. 3)		
	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery
Formaldehyde	2.347	2	117	3.85	3.2	120

TABLE B-5. INDIVIDUAL LABORATORY ANALYSES OF ROUND ROBIN SAMPLE F

TRACE ELEMENTS	LAB I		LAB II		LAB III		LAB IV		LAB V	
	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2
	PPM DRY WHOLE COAL BASIS									
As	4.82	50.43	35.51	35.07	17	17	24	ND	28.7	28.1
B	89.23	96.74	64.7	63.46	73	76	68	65	64.9	53.4
Ba	55.38	53.51	86.4	98.1	93	85.6	83	83	59	87.3
Be	2.67	2.78	2.14	2.18	1.9	2	2.3	2.4	2.75	2.41
Cd	0.07	0.09	0.1	0.12	<0.3	<0.3	<0.4	<0.4	0.093	ND
Cr	22.56	22.64	25.35	28.97	19.7	21.7	20	21	11	14.4
Co	9.74	11.32	5.9	5.88	6.23	6	8	7	4.56	3.59
Cu	21.54	21.61	17.35	17.07	<37.8	<37.4	20	21	22.2	29
F	<100	<100	90.46	92.55	90	100	ND	ND	63	65
Hg	0.21	0.27	0.238	0.251	0.24	0.26	0.25	0.25	0.336	0.323
Mn	25.64	15.73	26.6	26.6	27	23.2	30	31	25.5	26.6
Mo	7.38	6.48	4.25	4.46	3.65	3.8	<6	<6	1.92	1.51
Ni	26.67	29.84	21.98	22.39	26.8	28.2	25	28	23.5	23.8
Pb	7.28	<0.6	15.67	15.66	15	15	16	17	12.3	11.5
Sb	1.95	2.88	2.2	2.25	1.97	2.1	2	2	ND	ND
Se	1.13	2.26	3.27	3.29	2	2	3	ND	1.5	2.2
V	40	42.19	28.06	27.98	33.6	38.3	35	36	35.5	38.2
PROXIMATE & ULTIMATE	% DRY BASIS									
ASH	13.42	13.42	13.42	13.45	13.44	13.4	13.21	13.27	13.39	13.37
CARBON	66.75	66.24	71.23	71.11	71.34	71.38	70.41	70.23	69.98	69.94
HYDROGEN	5.3	5.28	4.76	4.77	4.94	4.88	4.63	4.58	4.77	4.75
NITROGEN	1.39	1.35	1.43	1.43	1.45	1.39	1.39	1.35	1.28	1.32
SULFUR	3.1	2.96	2.9	2.95	3.1	3	2.96	2.99	3.16	3.13
CHLORINE	0.6	0.05	0.155	0.14	0.119	0.122	ND	ND	0.12	0.13
Btu/lb	12207	10953	12674	12648	12645	12609	12665	12688	12623	12583
MAJOR ASH ELEMENTS	% DRY ASH									
SiO_2	45.86	49.3	47.18	46.04	ND	ND	44.91	ND	46.1	45.3
Al_2O_3	23.1	24.62	23.19	23.37	22.98	23.97	22.55	ND	22.1	22.2
TiO_2	1.12	1.23	1.06	1.07	1.3	1.12	1.12	ND	1	1
Fe_2O_3	20.76	23.02	21.68	22.01	20.9	19.67	ND	ND	21.4	21
CaO	1.18	1.07	1.85	1.91	1.44	1.36	ND	ND	1.7	1.8
MgO	0.43	0.33	0.87	0.87	0.73	0.86	ND	ND	0.86	0.86
Na_2O_3	0.22	0.21	0.3	0.3	0.25	0.25	0.38	ND	0.24	0.26
K_2O	2.39	2.22	2.3	2.32	1.92	2.11	2.05	ND	2.2	2.2
P_2O_5	0.47	0.53	0.48	0.46	0.89	0.89	ND	ND	0.45	0.46
SO_3	ND	ND	1.78	1.83	ND	ND	ND	ND	1.53	1.49

TABLE B-6. INDIVIDUAL LABORATORY ANALYSES OF ROUND ROBIN SAMPLE O

TRACE ELEMENTS	LAB I RUN 1	LAB I RUN 2	LAB II RUN 1	LAB II RUN 2	LAB III RUN 1	LAB III RUN 2	LAB IV RUN 1	LAB IV RUN 2	LAB V RUN 1	LAB V RUN 2
	PPM DRY WHOLE COAL BASIS									
As	46.12	35.85	34.96	36.04	21	18	27	ND	29.4	31
B	99.41	74.78	58.5	62.38	73	77	72	80	54.5	47.8
Ba	53.29	48.15	84.8	86.2	107	100	85	89	ND	85
Be	2.97	2.25	1.9	2.03	2.7	2.4	2.1	2.4	2.58	2.61
Cd	0.11	0.06	0.14	0.13	<0.3	<0.3	<0.4	<0.4	0.11	ND
Cr	22.55	18.44	20.68	19.39	21	22.6	20	20	13.3	13.9
Co	9.74	9.12	5.9	6.16	6.67	7.72	8	7	4.6	5.8
Cu	23.57	18.44	17.81	18.62	<31	<32.6	22	22	22.7	23.5
F	0.01	0.1	80.03	68.12	90	90	ND	ND	73	73
Hg	0.14	0.3	0.248	0.273	0.23	0.23	0.2	0.2	0.399	0.353
Mn	26.64	21.51	27.2	24.8	27.4	30.4	30	31	26	26.4
Mo	10.25	5.33	4.05	4.09	5.09	5.68	<6	<6	1.85	2.79
Ni	27.67	21.51	21.12	22.1	54.5	61.9	26	25	23.7	24.1
Pb	9.94	11.27	15.29	15.14	17	20	19	18	10.5	9.7
Sb	2.15	1.43	2.09	2.17	1.85	1.78	2	2	2.8	2.4
Se	2.05	2.15	3.39	3.37	2	3	3	ND	3.3	2.2
V	44.07	33.8	28.47	30.13	32.3	32.1	28	26	35.6	36.6
	% DRY BASIS									
PROXIMATE & ULTIMATE										
ASH	13.29	13.46	13.32	13.3	13.28	13.4	13.12	13.18	13.31	13.46
CARBON	69.61	69.56	71.35	71.16	71.19	71.46	70.38	70.79	70.5	70.66
HYDROGEN	5.06	5.24	4.82	4.78	4.91	5	4.6	4.65	4.76	4.79
NITROGEN	1.3	1.31	1.34	1.47	1.41	1.37	1.36	1.38	1.33	1.35
SULFUR	3.08	3.1	2.92	2.97	3.02	2.99	3.01	3.04	2.93	2.91
CHLORINE	0.02	0.02	0.13	0.13	0.127	0.13	ND	ND	0.12	0.12
Btu/lb	11774	11530	12737	12720	12654	12655	12690	12708	12644	12637
	% DRY ASH									
MAJOR ASH ELEMENTS										
SiO_2	52.88	39.14	46.16	46.9	ND	ND	42.89	ND	45.3	45
Al_2O_3	24.76	20.13	23.46	23.32	20.52	20.27	21.3	ND	22.5	22.6
TiO_2	1.29	0.96	1.09	1.08	1.03	1.02	2.32	ND	1.1	1.1
Fe_2O_3	23.15	17.41	22.28	22.17	20.6	22.79	ND	ND	21	21.4
CaO	1.19	0.97	1.84	1.8	1.31	1.22	ND	ND	1.7	1.7
MgO	0.37	0.44	0.86	0.87	0.83	0.77	ND	ND	0.85	0.85
Na_2O_3	0.24	0.21	0.31	0.29	0.25	0.25	0.36	ND	0.47	0.44
K_2O	2.51	2.11	2.32	2.32	2.27	2.33	1.72	ND	2.2	2.2
P_2O_5	0.53	0.4	0.48	0.47	0.97	0.85	ND	ND	0.49	0.53
SO_3	ND	ND	1.83	1.75	ND	ND	ND	ND	1.74	1.74

TABLE B-7. COMPARISON OF BOILER FEED COAL RESULTS WITH ROUND ROBIN RESULTS

Analyte	Average Table 5-6 Result (ug/g, as received)	Average Table 5-6 Result (ug/g, dry)*	Average Round Robin Result (F/O) (ug/g, dry)	Relative Percent Difference
Aluminum	14067	15052	15925	6
Antimony	1.1	1.18	2.1	56
Arsenic	33	35	26	30
Barium	55	59	76.1	26
Beryllium	1.9	2.03	2.37	15
Boron	72	77	70.7	9
Cadmium	ND<0.3	ND<0.32	0.085	116
Chromium	16	17	20	16
Cobalt	6.3	6.74	6.95	3
Copper	15	16	21.2	28
Lead	13	14	13.6	2
Manganese	25	27	26.5	1
Mercury	0.21	0.22	0.26	15
Molybdenum	ND<3	ND<3.21	4.54	34
Nickel	18	19	28.2	38
Potassium	2067	2212	2405	8
Selenium	ND<0.6	ND<0.64	2.56	120
Silicon	24567	26287	28499	8
Sodium	300	321	297	8
Titanium	800	856	976	13
Vanadium	28	30	34	13

*Calculated using average moisture value of 6.5 percent for boiler feed coal.

RESEARCH TRIANGLE INSTITUTE

RTI/5960/193 - 07D August 12, 1993

QA/QC AUDITS ON DOE UTILITY BOILER TEST PROGRAM

FIELD SAMPLING AUDIT REPORT

Site: Niles Station Unit 2, Niles, OH

DOE Contractor: Battelle

DOE Project Officer: Robert Evans

Performed for

Joseph A. McSorley
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RTI Work Assignment Leader: Shirley J. Wasson

Under EPA Contract No. 68D10009
Work Assignment No. I-193

POST OFFICE BOX 12194 RESEARCH TRIANGLE PARK, NORTH CAROLINA 27709-2194

Field Audit of:

Niles Station Unit 2
Ohio Edison
Niles, OH

Contractors: Battelle Memorial Institute
Chester Environmental
Dates: July 20 and 21, 1993
RTI Personnel: J.B. Flanagan and L.L. Pearce

Introduction

Niles Station Unit 2 is owned and operated by the Ohio Edison system and is located adjacent to the Mahoning River just south of Niles, Ohio. Unit 2 is a cyclone coal-fired boiler, burning bituminous coal from various sources. The coal has an average sulfur content of 3.0 percent. Typical gross electrical generation at full load is 100 MW. To maintain full load, four star-valve feeders supply approximately 44 tons per hour of coal into four burners. Approximately 20 to 30 percent of the ash in the coal is fly ash. An electrostatic precipitator (ESP) is the principal control for entrained fly ash. The rest of the ash, approximately 70 to 80 percent, is retained as molten slag in the bottom of the boiler and then drained into a tank filled with water.

A slipstream exits unit 2 prior to the ESP and is routed to the Innovative Clean Coal Technology Wet Gas Sulfuric Acid - Selective Catalytic Reduction of NO_x (ICCT WSA-SNOX) pilot plant managed by ABB Combustion Engineering. The WSA-SNOX process provides SO_2 and NO_x control on 35 percent of the flue gas from unit 2. There are no SO_2 or NO_x control systems for the remaining 65 percent of the flue gas. The WSA-SNOX process uses a selective catalytic reactor for the removal of NO_x and an SO_2 catalytic reactor in sequence with a cooling tower to convert SO_2 to sulfuric acid.

During the audit, the Niles plant had repeated operational problems with one of the four coal feeders. On Tuesday, July 20, sampling was postponed because of this problem. By 1:00 p.m. on Wednesday, July 21, this had been resolved, and a full day of organic sampling commenced. Thus, the entire sampling schedule was shifted.

Despite the schedule change, the auditors were able to complete all performance evaluation audits (PEAs) and audit questionnaires. In addition, more time was available on Tuesday and on Wednesday morning to interview the sampling personnel and to examine records. The auditors departed the site at approximately 6:00 p.m. on Wednesday.

Findings

1. Finding: **Particulate fractions data may be compressed because cyclones were operated in an extractive mode instead of in the stack.** In-stack sampling could not be performed because the ports were too small to allow the cyclones to pass through. Obtaining the sample required a sample probe and flexible Teflon line. According to Tom Kelly, up to 15 feet of tubing (probe length plus flexible line) were needed when performing a full traverse. When performing single-point sampling, shorter tubing runs were used. Battelle will wash the probe and lines to recover any particulate material lost.

   Effect on Data: Extractive versus in-stack cyclone sampling may lead to different results because of particle loss in the probe and lines. Depending on the gas flow rate, tubing diameter, tubing length, and aerodynamic diameter particle loss will vary.

   Rinsing the probe and flexible line is a good idea, but assigning all of this material to the first size fraction is questionable. See the Recommendation section of this report for a suggested investigation that might help clarify this issue.

2. Finding: **Glass cyclones of new design were used to collect particulate for size-fractionated analysis of metals.** According to George Sverdrup, these cyclones were of an original Battelle design and were developed specifically for this program and fabricated only weeks prior to the Niles field testing.

   Effect on Data: Unknown. Using all-glass cyclones should eliminate the chance of metal contamination that is possible with the use of metal cyclones, but because the cyclones were fabricated only a few weeks before the test, it is not known if validation testing was adequate.

3. Finding: **On one of the probes operated by Battelle, there was insufficient insulation to shield the thermocouple that controlled the temperature of the probe at 250°F from the high temperature flue gas.** Consequently, when the thermocouple entered the duct, approximately half-way into the traverse, the temperature controller shut down thereby allowing the portion out of the stack to drop below 250°F. In Figure 1, the controller is controlling the probe heater to heat the probe to 250°F. In Figure 2, the controller is turned off. The probe inside the duct is at a high temperature, ~380°F, while the probe outside the duct is at a lower temperature, ~198°F, measured by Battelle.

   Effect on Data: A few feet of the probe below 250°F seems unlikely to cause significant problems. This probe, operated at sampling point #19, should be compared with the probe at point #18 (which had adequate insulation) for evidence of any unexpected difference in probe rinse concentrations due to condensation in the unheated section.

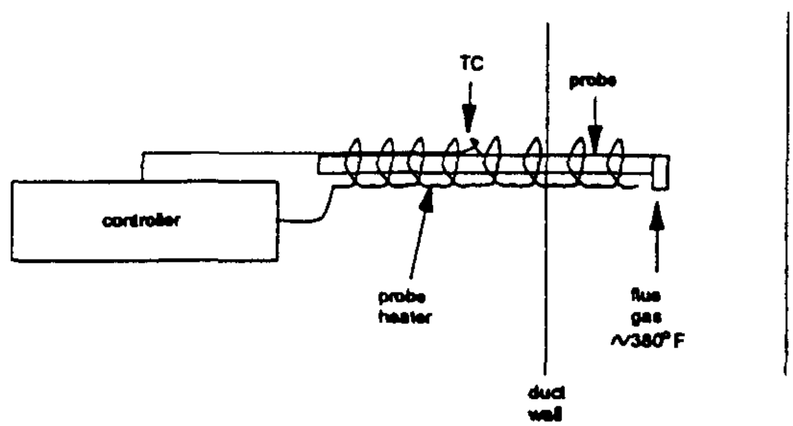

Figure 1. Thermocouple outside duct.

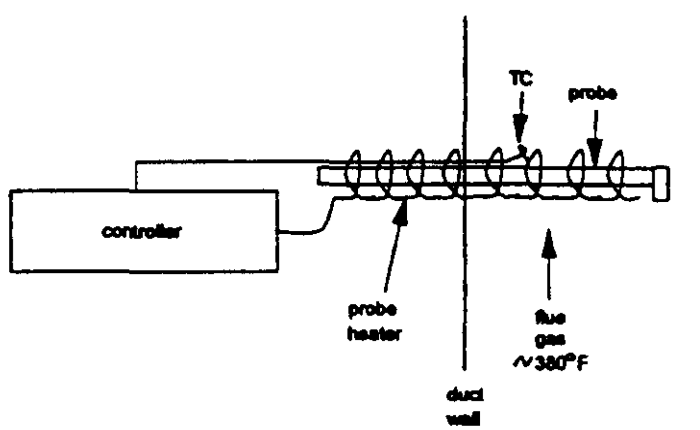

Figure 2. Thermocouple inside duct.

4. Finding: **The use of old absorbing solution in the Fyrite oxygen analyzers may have led to low oxygen results during the performance evaluation audit (PEA).** During the Fyrite oxygen analyzer PEA with analyzer set #1, the oxygen analyzer measured oxygen 24 percent low compared to RTI's standard gas cylinder. The second oxygen analyzer measured oxygen approximately 3 percent lower than RTI's oxygen standard. It was determined that the source of error may have been the use of old absorbing solution in the analyzer.

   Effect on Data: Even though Chester Environmental checked the Fyrite #1 periodically with ambient air, the oxygen analyzer continued to give erroneous results when challenged with a standard oxygen concentration. Checks of the Fyrite against a standard on a regular basis should be performed and the absorbing solution should be regularly replaced to prevent measuring incorrect oxygen concentrations at the flue gas sampling locations. Accurate oxygen measurements are necessary in determining the air in-leakage at the flue gas sampling locations for flue gas molecular weight calculations.

5. Finding: **The field balance used to weigh impinger solutions, drierite, etc., was not being calibrated using NIST-traceable weights.** Section 5.1.2.1, "Field Sampling Equipment," of the Sampling/Testing and QA/QC Plan states, "Field checks of balance accuracy will be made daily using a set of QC weights which have been weighed side-by-side with NIST-traceable weights."

   Effect on Data: This will have minimal effects on data because none of the weighings are used for analytical measurements. This balance was not used for weighing filters, impactor catch, or any other critical measurements.

6. Finding: **Water used for washing and making impinger solutions was a commercial brand of unknown chemical composition.**

   Effect on Data: The water should be carefully tested for the presence of any of the target analytes. If results show no contamination, or if background levels can be subtracted, there should be minimal impact on data.

7. Finding: **Glassware used by Battelle's subcontractor, Chester Environmental, for aldehyde analysis was of a different size than that used by Battelle.** Battelle used *midget impingers, while Chester used full-size impingers.*

   Effect on Data: Differences will probably be minimal, but without side-by-side comparison information, it would be impossible to be certain that the data are exactly comparable.

8. Finding: **There appeared to be some bleaching of the DNPH solution, particularly the second DNPH impinger, possibly due to the high levels of SO_2.**

   Effect on Data: Unknown. See recommendations section for a suggested investigation.

9. Finding: **Baghouse ash may have been contaminated by the sampling device.** Battelle employed a painted steel tube within a tube device for sampling baghouse ash. Ash samples were obtained by inserting the device into the ash hopper, collecting the ash sample, and dispensing the collected sample into an amber jar. Auditors noticed a few spots where the black enamel paint had flaked off the tube and rusty metal was exposed.

   Effect on Data: Sample contamination could result. The effect on the data is unknown, but trace metals analyses for these samples should be reviewed for any evidence of contamination.

10. Finding: **Sampling of the baghouse ash may not have been representative.** Baghouse ash was sampled from three of the six ash hoppers. This sampling configuration resulted from an obstructed sampling port for one of the ash hoppers.

    Effect on Data: Battelle assumed that all six hopers held identical material and the sampling ash from three hoppers was a representative sample of baghouse ash. Each of the ash hoppers will contain identical material given that there is a uniform flow of flue gas through the compartment of the baghouse and a uniform distribution of particles in the flue gas.

    Auditors observed a 90-degree elbow in the duct at the baghouse inlet. This sharp bend in the ductwork could cause some gas flow disturbances and result in uneven particle distribution. Since the velocity traverses are unable to be performed at this location, the discovery of any effects of this disturbance are pending laboratory analysis.

Observations

1. No grease was used with Battelle's sampling trains. Because train components had been preselected for good fit, leakage was held to a minimum. Chester appeared to use Teflon tape on some of the ground glass joints in their trains to minimize leakage.

2. The sampling ports that had been provided in the SNOX facility ducts were only about 2 inches in usable diameter. This limited the diameter of probes used and prevented in-stack use of larger devices such as cascade impactors and cyclones. Battelle and

Chester were well-prepared for most potential problems resulting from the small port openings; however, comparison of these data with those obtained at other sites may reveal differences due to extractive versus in-stack sampling.

3. Field personnel did not know if any single data base would be used to manage the analytical data. If a laboratory audit is performed, it would be a good idea to audit data transfers between the data bases.

Recommendations

1. The field balance should be checked daily with NIST-traceable weights. Checks should be recorded in the log book.

2. Water analyses, including reagent blanks for the impinger solutions made with the Magnetic Springs water, should be presented in the QC section of the final report.

3. The observed bleaching of DNPH solutions should be investigated. It is especially important to verify (1) that high levels of SO_2 or NO_x do not degrade the adducts after they are formed, and (2) that unreacted DNPH is not degraded to such an extent that there is incomplete capture of the aldehydes and ketones. Stack conditions could be recreated in the laboratory to investigate the reactivity of DNPH and adduct solutions with high SO_2 gas, high NO_x gas, and zero air.

4. A computer model should be run to estimate the amount of particulate material lost in the tubing between the sampling nozzle and the cyclones outside the stack. Results of size-fractionated chemical analysis should be corrected based on modeling results and probe and tubing wash data.

5. The all-glass cyclones fabricated by Battelle should be subject to validation testing since they are of a new design. Important considerations include accuracy of calculated cutpoints, presence of any static charge buildup on the nonconductive glass surfaces, and losses in the sample probe and flexible line leading from the duct to the cyclone.

6. Battelle should assure that Chester checks the Fyrite oxygen analysis against a standard on a regular basis and that the solutions are changed to appropriate intervals.

Activities

1. Performance Evaluation Audits (PEAs)

All scheduled PEAs were performed for the following:

- Paramagnetic oxygen sensors
- Fyrite oxygen analyzers
- Aldehydes
- Trace metals
- PAHs
- VOST
- Dry gas meter/standard orifice
- SO_2 and NO_x (ABB SNOX monitors)

The results of the paramagnetic oxygen sensor PEA, the Fyrite oxygen analyzer PEA, and the CEM PEA are shown in Tables 1 through 3. Chester Environmental's dry gas meter audit results were within 2 percent of the standard critical orifice measurements. Battelle's dry gas meter audit data had not been received as of August 2, 1993. Sandy Anderson, the QA Officer, was contacted concerning the missing information.

2. Technical Systems Audits (TSAs)

Because of plant operational problems, not all sampling trains were observed; however, all basic activities including traverses, glassware and train preparation, and recoveries were observed. Recovery of material from the cyclones was not observed because the auditors were not present on an inorganics test day. Some additional calibration data not present at the site were requested.

Personnel Present During Site Visit

Name	*Organization*	*Telephone*
Robert Evans	DOE	
George Sverdrup	Battelle	(614) 424-5014
Paul Webb	Battelle	(614) 424-5014
Tom ~~John~~ Kelly	Battelle	(614) 424-3495
Debbie Smith	Battelle	(614) 424-4114
Joe Tabor	Battelle	
Raj Rangaraj	Battelle	
Sandy Anderson	Battelle	(614) 424-5220
John Hilborn	Ohio Edison	(216) 384-5768
Mark Grunebach	Chester Environmental	
Timothy Cassell	ABB	(216) 652-4881
Jim Flanagan	RTI	(919) 541-6417
Lori Pearce	RTI	(919) 541-7182

TABLE 1. PARAMAGNETIC OXYGEN SENSOR PEA RESULTS

	RTI (Audit Standard)	Battelle	% Difference*
Model 570A	Serial No. X-48490		
Zero (pure N_2)	0.0	-0.2	---
O_2 (%)	9.21	9.10	-1.20
Model 580A	Serial No. X-43454		
Zero (pure N_2)	0.0	0.0	---
O_2 (%)	9.21	9.00	-2.30

* Acceptance limits were not provided in the QA Plan. A reasonable acceptance limit of ± 10% was used by RTI in evaluating the PEA data.

TABLE 2. FYRITE OXYGEN ANALYZER PEA RESULTS

	RTI (Audit Standard)	Chester Environmental	% Difference*
Set #1			
Zero (pure N_2)	0.0	0.0	---
O_2 (%)	9.21	7.00	-24.0
Set #2			
Zero (pure N_2)	0.0	0.0	---
O_2 (%)	9.21	8.95	-2.82

* Acceptance limits were not provided in the QA Plan. A reasonable acceptance limit of ± 10% was used by RTI in evaluating the PEA data.

TABLE 3. SNOX CEM AUDIT RESULTS

	RTI (Audit Standard)	ABB	% Difference*
O_2 (%)	9.21	9.02	-2.10
SO_2 (ppm)	1549	1555	0.40
NO_x (ppm)	815	810.5	-0.55

* Acceptance limits were not provided in the QA Plan. A reasonable acceptance limit of ± 10% was used by RTI in evaluating the PEA data.

INTERNAL AUDIT REPORT

on

A STUDY OF TOXIC EMISSIONS FROM THE
NILES STATION BOILER NO. 2 AND WSA-SNOX PROCESS

to

U. S. Department of Energy
Pittsburgh Energy Technology Center

(Contract DE-AC22-93PC93251)

Prepared by

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INTERNAL AUDIT REPORT

on

A STUDY OF TOXIC EMISSIONS FROM THE
NILES STATION BOILER NO. 2 AND WSA-SNOX PROCESS

INTRODUCTION

This report summarizes the audit activities conducted on-site at Ohio Edison's Niles Station WSA-SNOX demonstration project and at Battelle Columbus Laboratories from the time period of July 19 through October 11, 1993. As Project Quality Assurance Officer (QAO), I observed field sampling and laboratory activities which were compared to descriptions provided in the Management Plan for 'Study of Toxic Emissions from a Coal-Fired Power Plant Demonstrating the ICCT WSA-SNOX Project and a Plant Utilizing an ESP/Wet FGD System' (DOE Contract DE-AC22-93PC93251) dated June 21, 1993, and the 'Final Niles QA/QC, Sampling, and Analytical Plans', dated July 17, 1993, under the same contract number.

During these observations, I recorded detailed notes which are summarized on the attached Checklists including general information (date, place, time, what, who), a brief narrative account, sample collection and related procedures, comments and recommendations. All of the recommendations were discussed in real-time with either the Project Manager, Assistant Project Manager, Field Sampling Manager, or Analysis Leader as soon as possible after the observation. Corrective action was implemented in most instances before the QAO left the inspection site or within a reasonable time length thereafter.

SUMMARY

Field and laboratory inspections conducted during Niles Station, SNOX Process Power Plant activities indicated that, for the most part, the QA/QC Plan of July 17 was being followed as written, or according to formal, written deviations as described in 'Technical Note, Volume 1 of 3 - Sampling' dated November 1993. These deviations were initiated either as a need for corrective action or because the technical and physical demands of field and laboratory operations precluded adhering to the original QA/QC Plan.

On-site field observations included: sample tracking, custody, storage, and shipping procedures; in-process sampling at Locations 20, SCR Reactor Outlet; 19, Baghouse Outlet; and 18, Baghouse Inlet. SNOX Process sampling was observed at Locations 1 (Boiler Feed Coal), 24 (Baghouse Ash), and 22 (Sulfuric Acid). Various sampling train recovery and preparation procedures were also observed.

The Battelle QAO also served as a point of contact, along with the Project Manager and Field Sampling Manager, for RTI personnel conducting an independent field audit on July 20-21, 1993. In the absence of the Field Sampling Manager, subsequent to the field sampling phase, the QAO provided the following to RTI Auditor L. Pearce: type S Pitot tubes calibration sheets dated July 13; completed Multimetals Train data sheets from sampling Location 19 (Run N-19-MUM-722) as requested by RTI's Jim Flanagan; nozzle calibration data forms dated 06/12/93 and 07/26/93, including one for Chester nozzle 54; and continuous instrument calibration data forms for Servomex 580A instrument (dated 07/24/93) and Servomex 570A instrument (dated 07/20/93). These are described in a letter to Ms. Pearce dated August 9, 1993.

Laboratory observations included: sample receipt, log-in, custody, and storage procedures; PAH/SVOC liquid samples extraction and concentration; systems audit of VOC-Canister sample receipt and analysis; anion analysis by ion chromatography and data tracking; PAH/SVOC liquid samples preparation; PAH/SVOC gas and liquid samples, filter preparation; PAH analysis by GC/MS and Dioxin/Furan analysis by GC/MS.

Following is a sequential account of Niles Station SNOX Process audit activities, each with a brief narrative and QAO's recommendations when applicable. For detailed records, dated observations recorded on either the Field Inspection Checklist or Laboratory Inspection Checklist should be consulted.

CHRONOLOGY

Sampling Day 02, 19 July 1993:

Observations: Process Sampling for Boiler Feed Coal at Location 1. Half-hour process samples were collected from each of the coal feeders with a painted, metal scoop into a cleaned coffee can and subsequently emptied into a plastic bag for compositing. Random-sized coal pieces are left in the sample collection. Impinger and train recovery procedures were observed for cyanide and multimetals, Location 19 baghouse outlet; and particulate filter recovery for Location 18, baghouse inlet. Impingers and trains arrived at the recovery sites on ice and connections were wrapped with tape when applicable. Rinsing, container, and collections procedures followed the QAP; Method 29 filter holder was brushed and wiped out, and reloaded for use at the same site location. Container labels and chain-of-custody forms were completed. Location 20, SCR reactor outlet, in-process sampling conducted by Chester staff, was observed as well as the sample preparation trailer used by the subcontractor team. Horizontal traverses as well as temperature and meter readings were noted.

Recommendations: Use of a painted scoop for boiler feed coal samples was discussed with the on-site Project Manager. Niles staff were requested to provide overnight sample custody for collected samples and to initial the last day's collection on the data form for traceability. Excursion from the QAP pg. 5.2-18 description of collecting into "precleaned glass bottles" must be addressed as a deviation. Sample custody and transfer must be clarified for times when samples are being transferred and the designated sample custodian is fulfilling sample collection obligations (three times daily samples for baghouse ash, Location 24). Individuals responsible for train recovery should also be clearly identified. Data sheets from sampling locations were observed with either no clock times for start/stop or names recorded were noted and this was discussed with the field sampling manager immediately.

Issues above were discussed during the second sampling day with Project Manager Sverdrup and Field Sampling Manager Tom Kelly. A formalized list of deviations was to be initiated and will be updated as needed, to describe departures from the QAP and the impact of the changes on the study.

Response: The deficiencies in documentation of data sheets, sample recovery, and sample custody were addressed immediately following the QAO's comments by directions and reminders to the pertinent staff in the field. The coal collection device caused no contamination of the coal samples, due to the large sample size collected and the lack of damage to the device itself. Use of plastic bottles has been noted as a deviation from plan in the Draft Final Reports on the Niles sampling.

Canceled Sampling Day, 20 July 1993:

Observations: Process sampling from baghouse ash Location 24 was observed early in the day. However, because of sampling program cancellation due to plant problems, this was the only process sample collected on this day. Time was dedicated to the accommodation of the RTI performance audit activities. This included oxygen meter checks with standard cylinders provided by RTI; spiking of XAD-2 traps and filters; initiation of dry gas meter audits for Locations 18 and 19, using an EPA standard orifice supplied by RTI. A detailed examination of the sample processing, custody, and shipping procedures was conducted by the Battelle QAO.

Recommendations: There was no standard calibration form available on site for either Battelle or the subcontractor on which to record results of the RTI audit. Discussed data entry correction procedure with the Field Sampling Manager to eliminate obliterations of corrected values on sampling data forms. Situation was discussed with the custodian and train recovery leader in which filters prepped after recovery late on 07/19 were properly stored and labelled but were not logged onto the chain-of-custody form by mid-day of July 20.

Response: Further discussions were held with field staff responsible for the sample documentation and custody. The minor lapses still found in these areas were due to the conditions of field work and the large numbers of samples being logged in.

Sampling Day 03, 21 July 1993:

Observations: RTI staff continued the conduct of their performance audit. The Battelle QAO reviewed sample packaging and shipping procedures. "Cold" samples such as impinger solutions, XAD-2 traps, VOCS and SVOCs are shipped out daily on ice via courier. Process coal and preserved samples are shipped back to labs at the conclusion of sampling. VOC SUMMA canisters are shipped out within 24 hours of collection. All sample container labels are covered with clear tape, the containers wrapped in bubble wrap and double plastic bags for shipment. Receipt and temporary storage of Chester VOST tubes were observed. Baghouse inlet sampling at Location 18 was initiated with a dry gas meter calibration ongoing while the sampling team was setting the probe in place for the first of 22 vertical traverse sampling points. The second sampler was setting up for a horizontal traverse. Baghouse outlet sampling at Location 19 included setting up of the Nutech Stack Sampler, a critical orifice check and set up of the aldehyde impinger on the lower platform. The vertical traverse probe was already set up for the first sampling point. Transfer of SUMMA canisters to Locations 18 and 19 with chain-of-custody forms and cross check of canister identification tags were noted (88-044, 89-005, 88-033). Sulfuric acid sampling at Location 22 by ABB staff was observed from the tank under the SNOX tower. The sample was collected into a precleaned and labelled amber glass bottle and constituted the daily sample. RTI's spiking of two aldehyde trains was noted.

Recommendations: There were no additional recommendations for sampling day 03 observations.

A verbal debriefing was conducted by RTI and included the following highlights: Battelle is using bottled DI water that does not meet method requirements for ASTM Type II water. Even though blanks are run, consideration should be given to using bottled ASTM water. There is concern over use of a painted metal scoop for the coal feeder Location 1 process samples. The oxygen analogue meter was noted to be out of specified calibration ranges. There are differences in the aldehyde train connections: Battelle uses dry connections and a different sized impingers than Chester, which uses Teflon tape on ground glass joint connections. Fyrite tubes Chester is using must have a once/day standards check for accuracy. Additional minor points included whether quartz or glass filters were used for dioxin sample collection since the QA Plan didn't specify, and a question as to how glass end caps for sampling trains were stored during sampling.

Response: Most of the items noted in the RTI debriefing have been addressed in the Draft Final Reports on the sampling studies conducted at the Niles-SNOX and Niles Boiler No. 2. In both reports, responses to the RTI comments are presented in Appendix B: Auditing. Quartz fiber filters were used for all sampling. Glass end caps were covered in aluminum foil or kept in plastic bags during sampling.

Sample Receipt and Log-in, July 29, 1993

Observations: Samples for N 5a MUM 727, N 4 MM5 728, N 13 PRL, and N 8 PRS samples were tracked from evening delivery to the Battelle lobby, transfer by the Laboratory Sample Custodian to the receipt and log-in area, to final storage locations prior to preparation and analysis. Three coolers and seven boxes of liquid, solid, and filter samples were cross-checked between container label information and completed chain-of-custody forms prior to being logged into the custodian's record book.

Recommendations: Several discrepancies from the sampling aspects of the QA/QC Plan were noted and discussed with the Custodian and the Field Sampling Manager. Certain of these are to be addressed as deviations to the QA/QC Plan; others for which subsequent data were completed to assure traceability of samples and completeness of the sampling record, should be addressed for future studies by more vigorous training of field staff prior to departure for the sampling site. QAP pg. 5.2-22 specifies 4-liter bottles for collection of samples from Locations 9, 10, and 13. 500-ml amber glass bottles of samples were received from these sites. Location 9 'river water' is referenced as 'makeup water' in the QAP. Sequential samples for N 13 PRL 729 and others were noted with identical labels for all four containers. Subset identifiers should be added for traceability for this type of replicate sampling, which is not spelled out in the QAP. Discrepancies in sampling times between the container labels and completed chain-of-custody forms varied from a few minutes to an hour. Certain sampling team members used only their first names on forms and labels. The

Laboratory Sample Custodian documented labelling and sample container discrepancies on both the custody form and the sample record logbook.

Response: As noted, some discrepancies were observed in documentation of samples. However, all such discrepancies were resolved in the chain-of-custody review process prior to sample analysis, and all samples were identified and accounted for. Improvements in the sample numbering scheme will be made in any future work. The collection of liquid samples is noted as a deviation from plan in the Draft Final Reports on the Niles sampling efforts.

PAH/SVOC Liquid Samples Extraction and Concentration, 04-05 August 1993

Observations: Method 3510 was followed for extraction, pH adjustment, spiking, and concentration. Spiking and surrogate solutions are traceable to neat stocks. Samples were labelled properly through the 2-day process and custody procedures observed through final transfer to the analyst. N 9 PRL 730 samples for pond water, river water, trip, and field blanks were tracked for this observation.

Recommendations: There were no recommendations for these observations.

VOC-Canister GC/MSD Analysis, 05 August 1993:

Observations: A system audit was conducted of VOC-canister analysis, from transfer to the analyst by the Lab Sample Custodian, instrument calibration with a 42-component NIST-traceable standard, sample analysis, data acquisition and review, and transfer to canisters for recleaning. VOC canisters are shipped within 24 hours of field collection and the analysis is initiated the next morning after sample receipt to maintain the holding time limitation of 2 days.

Recommendations: Clarification of using a 42-component, rather than the QAP p. 4.1-14 'containing the 41 target compounds' should be added to the study record. This is not technically a deviation, however.

Response: The cylinder used for calibration contained 42 compounds; however, for this study, only 41 compounds were targeted for analysis.

Ion Chromatography Analysis, 11 August 1993:

Observations: Process water samples from 728 are received in 40-ml amber vials and the labels checked to the chain-of-custody form copy. Twofold dilutions of samples are made using a calibrated autopipettor. Standard, calibration, and spiking solutions are traceable to a separate logbook. EPA Method 300.0, December 1989, is used as a guideline. EPA PE Standard WP029 is used as an accuracy check solution for Dionex instrumentation. Sample custody is documented from receipt through analysis. The analyst reviews generated data and sets up a data file for each set of samples that includes: Final Anion Report, Summary Report, Calibration Plots, Duplicate and Spike Data, Standards Prep Data, Analysis Conditions and Chromatograms.

Recommendations: Minor clerical traceability issues were discussed with the analyst. Reference to the specific method guidelines used and brief description of the sample preparations should be added to the study record book.

Response: Reference to specific method guidelines and a description of the sample preparation procedure were added to the study record book.

PAH/SVOC Gas and Liquid Filter Preparation, 20 August 1993:

Observations: N F 730 samples for Locations 5a, 5b, and 4 were observed from initial custody transfer, through column chromatography, extraction, spiking with internal standard, concentration, and storage until analysis. Chromatographic reagent preparation and glassware preparation were discussed with the analyst. Sample labels reflect identity throughout the process and tracking documentation is also described in the study record book.

Recommendations: Calibration of the storage refrigeration unit thermometer was suggested, as well as a lock on the freezer where sample extracts are stored. The latter suggestion was implemented within the next day or two and alleviated the problem of unassured sample custody after working hours caused by a faulty door lock in the laboratory area.

Response: The storage refrigeration unit thermometer was calibrated as suggested.

PAH Analysis by GC/MS, 20 August 1993

Observations: Tuning, calibration, and analysis of the first sample extract was observed. A Battelle Facility SOP describes the analysis using the Finnegan MAT TSQ GC/MS. The instrument logbook records the sample ID, file ID, and laboratory record book reference number. Freezer for instrument standards is monitored. Sample analysis flow begins with an instrument tuning run, standard, standard, sample, sample, sample, standard at end of the run. The Lab Analysis Manager determines when corrective action is needed and also performs the action. Third party review of data and spreadsheet is performed before transfer of data for reporting.

Recommendations: No recommendations were made for this observation.

Dioxin/Furan Analysis by GC/MS, 11 October 1993

Observations: Samples are stored in a monitored freezer from transfer through analysis. MM5 Site 5a filter was tracked as a filter extract from the prep logbook to the Mass Spec logbook. Sample custody and transfer is also documented in the Dioxin Lab sample logbook. Five point recalibration is performed initially for the dioxin analysis, with continuing calibrations being performed at periodic intervals. Calibration standards are made up by the Standards Custodian from commercially available standards, as are window mix and column performance checks. The MS logbook documents operating parameters, as well as file ID, Lab ID, sample ID for cross reference, injection volume and clock time of injection. Instrument used is VG Analytical HP5890A GC, and 11-250J computer which was last validated on 07/07/93, according to the facility SOP. Sample analysis flow begins with performance checks, calibration, decane blank, samples (including QC), and calibration point at the end of the run.

Recommendations: No recommendations were made for this observation.

FIELD INSPECTION CHECKLIST

AUDITOR S M Anderson DATE 19 July 1993

STUDY NUMBER 930214 SITE LOCATION Niles Station, Niles, Ohio

SNOX Process TIME 2P; 540P Day 02

STUDY PROTOCOL/QAPP QA/QC Plan DE-AC22-93 PC93251

Field Phase Inspected Process Sampling Boiler Feed Coal Location #01

Personnel Involved Niles Staff - Fred

Protocol/QAPP/SOP Requirements QAP pg 5.2-~~21~~ 18 error SMA 07/23/93 5.2-18, 19 (Process)

Narrative Account Half hour sample collected into pre-cleaned glass bottle per QAP p5.2-18 changed to one scoopful of coal removed from each hopper into a coffee can. Random sized coal pieces are left in can. Samples collected every half hour when the sampling team is collecting only

Sample collection, containers, custody and transfer procedures ________

SMA

Additional Comments Requested that last day's entry be initialled by sampler for traceability. Data form will note any system shutdown. Painted metal scoop used to collect. Sple. will be emptied from coffee can into plastic bag for compositing.

Recommendations Process coal samples stored near boiler. Rec. moving samples to more secure location & assure custody for overnight collection of samples①

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① Excursion from QAP 'glass bottle' should be noted in deviations for site

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FIELD INSPECTION CHECKLIST

AUDITOR S M Anderson DATE 19 July 1993

STUDY NUMBER SC930214 SITE LOCATION Niles Station Niles, Ohio

SNOX Process TIME 2P, 4P Day 02

STUDY PROTOCOL (QAPP) QA/QC Plan Contract DE-AC22-93PC93251

Field Phase Inspected Cyanide Impinger Recovery Baghouse Outlet Location 18 19 error in location SMA 07/23/93

Personnel Involved Raj Rangaraj

Protocol/QAPP/SOP Requirements QAPP 5.2-10, pg 5.2-42, 43; 5.3-7, 8

Narrative Account Observed impinger collection, rinse and transfer to labelled sample jars, weigh check of impinger

Balance used = Mettler P1200 N, Calibration due 09/93

Sample collection, containers, custody and transfer procedures Spl. Custodian is also collecting samples at this site. A designated back-up must be named to log in samples when she is unavailable.

Additional Comments Refrigerated samples to be left outside in cooler under trailer are to be brought inside for security until shipment to lab.

Recommendations No clock times recorded for sampling start/end time. Need to indicate approximate times on data sheet. "Completed by" on sample labels need to be

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filled out consistently by either Train Recovery Leader or sampling team recovery person

FIELD INSPECTION CHECKLIST

AUDITOR SMAnderson DATE 19 July 1993

STUDY NUMBER SC930214 SITE LOCATION Niles Station, Niles, Ohio

SNOX Process TIME 805P Day 02

STUDY PROTOCOL(QAPP) DE AC 22-93 PC 93251 16 July 1993

Field Phase Inspected Method 29 Train Recovery, Baghouse Outlet, Location 19

Personnel Involved Joe Fisher

Protocol/QAPP/SOP Requirements QAP p5.2-17, 23-24, 28, 29, 30

Narrative Account Recovery of multimetals train. Train arrives side arm wrapped c teflon tape. Train recovery procedures followed fig 5-14, p 5.2-30 QAP

Sample collection, containers, custody and transfer procedures Spl. labels for train components filled out as 'completed by' Joe Fisher. Bottles for recovery rinses are precleaned amber & have label already on them.

Additional Comments None

Recommendations None

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FIELD INSPECTION CHECKLIST

AUDITOR S M Anderson DATE 19 July 1993

STUDY NUMBER 9130214 SITE LOCATION Niles Station, Niles, Ohio

SNOX Process TIME 5P Da 02

STUDY PROTOCOL/QAPP

Field Phase Inspected Particulate Filter Recovery, Bypass Inlet, Location 18

Personnel Involved Joe Tabor

Protocol/QAPP/SOP Requirements QAP pg 5.2-9

Narrative Account Method 29 particulate filter transferred to labelled petri dish. Filter holder brushed and wiped out, reloaded and used again for same site location

Sample collection, containers, custody and transfer procedures Petri dish has sample label affixed by Joe and custody form completed

Additional Comments None

Recommendations None

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FIELD INSPECTION CHECKLIST

AUDITOR S M Anderson DATE 19, 20 July 1993

STUDY NUMBER SC930214 SITE LOCATION Niles Station, Niles, Ohio

SNOX Process TIME 2308 Day 02

STUDY PROTOCOL/QAPP DEAC22-93PC93251 16 July 1993

Field Phase Inspected MUM Method 29 Sampling Location 20

Personnel Involved (SCR Reactor Outlet) Chester Staff

Protocol/QAPP/SOP Requirements QAP pg 5.2-17

Narrative Account Observed in-process sampling and horizontal traverse. Train iced. Staff taking temp. & meter readings but talking c S. Kelly re. possible plugged filter. only one SMA 11/23/93

Sample collection, containers, custody and transfer procedures Checked trailer Chester is using for sampling prep. Is neat and well-organized. Reminded staff of importance in completing sampling data forms as work is done. ①

Additional Comments Observed set-up on non-sampling da as Chester staff was working c sampling port valve modifications to accomodate probes. Are sampling 4/6 ports only.

Recommendations Field Splg. Leader & Chester staff to discuss sampling difficulties & change in splg time on 07/19/93

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① MUM custody signed over to D. Smith.

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FIELD INSPECTION CHECKLIST

AUDITOR S M Anderson DATE 20 July 1993

STUDY NUMBER SC93024 SITE LOCATION Niles Station, Niles, Ohio

SNOX Process TIME 850 A

STUDY PROTOCOL/QAPP DE-AC22-93PC93251 16 July 1993

Field Phase Inspected Baghouse Ash Sampling Location 24

Personnel Involved Debra Smith, RTI Observer

Protocol/QAPP/SOP Requirements QAP p 5.2-18, 19

Narrative Account 1st of three daily ash samples collected using elevated hoist and ADB sampling tube. new bags installed 2-3 weeks ago. 07/20 was a canceled sampling day. This was the only process spl. collected.

Sample collection, containers, custody and transfer procedures Spls. dumped from tube into clean, labelled glass jars transported in cardboard box to trailer where custody forms are completed.

Additional Comments None

Recommendations None

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FIELD INSPECTION CHECKLIST

AUDITOR JMAnderson DATE 20 July 1993

STUDY NUMBER SC130214 SITE LOCATION Niles Station, Niles Ohio

SNOX Process TIME 1020A

STUDY PROTOCOL/QAPP DE-AC22-93PC93251 16 July 1993 ① error JMA 07/23/93

Field Phase Inspected Performance audit RTI, CEM Calibration

Personnel Involved Paul Webb, L. Reace

Protocol/QAPP/SOP Requirements and RTI letter of 15 July 1993

Narrative Account Oxygen meter Calibration Check

(Battelle X48490, Servomex 570A); calibrated using

Battelle cylinder. Readings N_2 1700 psi

O_2 50 ppm

11:40A 570A N_2=9.1 O_2 N_2 9.8 1580A= O_2=0.0 O_2 N_2 9.0 (vsRTI 9.2)

Sample collection, containers, custody and transfer procedures Not Applicable

Additional Comments None

Recommendations No calibration form was available on which to record results of calibration. Readouts must be retained on traceable data record form or book

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FIELD INSPECTION CHECKLIST

AUDITOR J M Anderson DATE 20 July 1993

STUDY NUMBER 93024 SITE LOCATION Niles Station, Niles, Ohio

SNOX Process TIME 12P, 1210P

STUDY PROTOCOL/QAPP DE-AC22-93PC 93251 16 July 1993

Field Phase Inspected Oxygen Indicator (Fyrite Set 01) Subcontractor

Personnel Involved Mark Grunebach, Chester; RTI Staff

Protocol/QAPP/SOP Requirements and RTI letter of 15 July 1993; p5.1-35

Narrative Account Fyrite #9 Calibration at 2X = 0.0, <0.0
RTI recommends using a certified Standard to recheck Fyrite set

Sample collection, containers, custody and transfer procedures Not applicable

Additional Comments ~~Observed~~ error SM RTI J. Flanagan doing XAD-2 spikes on 2X filters and traps using an RTI Performance Audit Solution

Recommendations Above in narrative

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FIELD INSPECTION CHECKLIST

AUDITOR S M Anderson DATE 20 July 1993; 21 July 1993

STUDY NUMBER SC930214 SITE LOCATION Niles Station, Niles, Ohio

SNOX Process TIME 1225 P

STUDY PROTOCOL/QAPP DE AC-22-93PC93251 16 July 1993

Field Phase Inspected Sample Processing and Custody

Personnel Involved Debra Smith

Protocol/QAPP/SOP Requirements QAP pg 5.1-25 & 29

Narrative Account Labels and custody forms completed for 07/19 samples; Chester samples sent to Battelle for locations 20, 21, MUM on 07/19. Chester relinquishes custody to Deb Smith who then sends spls. to Battelle with original chain of custody forms

Sample collection, containers, custody and transfer procedures Custody form (above) copied and provided to Chester. Original form will be received by Laboratory Sample Custodian in Columbus. Trailer well supplied c labels and forms.

Additional Comments Reviewed Sampling Data sheets on 07/21/93. Source Sampling data sheets need to be recorded as completely and legibly as possible because traceability (Aldehydes, VOST, CN, Acid Gas, NH_4)

Recommendations See above and note that Corrections must not obliterate original entry. Use single line-thru process

contd on 21 July 93

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Issue noted 07/20. Filters prepped after recovery late on 07/19 were properly stored on dry ice but not logged onto the custody form by Train Recovery leader. Discussed w/ Chester and Deb Smith

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FIELD INSPECTION CHECKLIST

AUDITOR Sandy M Anderson DATE 21 July 1993 02

STUDY NUMBER SC930214 SITE LOCATION Niles Station, Niles, Ohio

SNOX Process TIME 2454 day 03

STUDY PROTOCOL/QAPP DE AC-22-93PC93251 16 July 1993

Field Phase Inspected Sample Processing and Custody Cont'd

Personnel Involved Debra Smith

Protocol/QAPP/SOP Requirements QAP pg 5.1-25 to 29

Narrative Account Chain of custody records review & processing: ambient temperature samples retained inside trailer and shipped back to Battelle at end of study. "Cold" samples are shipped out daily on ice via courier. Process coal and H_2SO_4 samples①

Sample collection, containers, custody and transfer procedures VOST samples are Chester staff's responsibility. We store their VOST tubes in our refrig only; retain C of C copies after spls. are relinquished to Chester for analysis

Additional Comments ① are also shipped back at the end of the study. Filter spls. for MM5 are shipped out on dry ice. All spl. container labels are covered c clear tape, wrapped in bubble wrap, 2X

Recommendations plastic bags then shipped on ice.

① Battelle needs to design a calibration form for O_2 and other analyzers. Should fit generic use but still

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serve as a prompt for user to complete information. Discussed c Tom Kelly.

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FIELD INSPECTION CHECKLIST

AUDITOR M Andeum DATE 21 July 1993

STUDY NUMBER 2930214 SITE LOCATION Niles Station, Niles, Ohio

SNOX Process TIME 740A day 03

STUDY PROTOCOL/QAPP QA/QC Plan DE-AC22-93PC93251 07.16.93

Field Phase Inspected Baghouse Inlet Sampling Location 18

Personnel Involved Paul Webb, Kent

Protocol/QAPP/SOP Requirements QAPP P 5.2-10

Narrative Account Dry Gas Meter calibration at location while setting probe for vertical traverse. Collecting 22 valid sampling points on the vertical. Points on probe marked with tape. Second sampler was setting up for horizontal traverse.

Sample collection, containers, custody and transfer procedures

Additional Comments Particulate Field Data forms - reminded sampling team to complete as much information as possible before transferring these forms to the sample custodian

Recommendations

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FIELD INSPECTION CHECKLIST

AUDITOR L M Anderson DATE 1200 ~~22~~ 23 July 1993

STUDY NUMBER 5C430214 SITE LOCATION Niles Station, Niles, Ohio

SNOX PROCESS TIME 930A day 03

STUDY PROTOCOL/QAPP QA/QA Plan: DE-AC22-93PC93251 07.16.93

Field Phase Inspected Baghouse Outlet Sampling Location 19

Personnel Involved Harry Leonard

Protocol/QAPP/SOP Requirements QAP 5.2-17

Narrative Account Nutech Stack Sampler undergoing a Critical Orifice Check. Observed aldehyde impinger train being set up on lower platform. Vertical traverse probe already set up for first sampling point. Distances marked on probe.

Sample collection, containers, custody and transfer procedures In-process sampling not yet initiated.

Additional Comments Harry had discussion c Jim Flanagan re probe temp ≥ 250°±25 requirement in method for last two sampling points. Harry will do a single run to provide gas temp. & verify no significant heat loss.

Recommendations None

FLDLST.05/93 Auditor's Signature and Date Larry M. Anderson 23 July 1993

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FIELD INSPECTION CHECKLIST

AUDITOR S M Anderson DATE 21 July 1993

STUDY NUMBER 3CI3024 SITE LOCATION Niles Station, Niles Ohio

SNOX Process TIME 12 noon day 03

STUDY PROTOCOL/QAPP QA/QC Plan DE AC22-93PC93251 07.16.93

Field Phase Inspected Summa Canister Transfer to Locations 18, 19

Personnel Involved Paul Webb, Henry Leonard

Protocol/QAPP/SOP Requirements QAPP p 5.2-39

Narrative Account Summa canisters were taken to base of each sampling platform with chain of custody samples for each. Cross-checked tag numbers on cannisters.

Sample collection, containers, custody and transfer procedures Battelle X numbers for these SUMMA Canisters: 88-044

89-005

88-039

Additional Comments None

Recommendations None

FLDLST.05/93 Auditor's Signature and Date Sandy M Anderson 21 July 1993

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FIELD INSPECTION CHECKLIST

AUDITOR SMAnderson DATE 21 July 1993

STUDY NUMBER SC1302/14 SITE LOCATION Niles Station, Niles, Ohio

TIME ~130P day 03

STUDY PROTOCOL/QAPP QA/QC Plan TE AC22-93PC93251 Dated 16 July 1993

Field Phase Inspected Sulfuric Acid Sampling, Location 22

Personnel Involved ABB Staff

Protocol/QAPP/SOP Requirements QAP p5.2-19

Narrative Account Observed sample collection from tank under SNOX tower. Sample collected into precleaned amber glass bottle. This constitutes daily sample for this process.

Sample collection, containers, custody and transfer procedures none

Additional Comments none

Recommendations none

FLDLST.05/93 Auditor's Signature and Date Sandy M. Anderson 23 July 1993

LAB INSPECTION CHECKLIST

AUDITOR Sandy M. Anderson DATE 29 July 1993

STUDY NUMBER SG930214 SITE LOCATION Niles Station, Niles, Ohio

→ Battelle Room 6028 TIME 603 P to 8 P

STUDY PROTOCOL/QAPP QA/QC Plan DE AC 22-93PC 93251 07-16-93

Lab Phase Inspected Sample Receipt and Log-In

Personnel Involved Sue Champagne, Jan Satola

Protocol/QAPP/SOP Requirements QAP pg 5.1-29-32

Narrative Account Samples picked up in lobby at 603P and transferred to room 6028 (locked), included three coolers and seven boxes. LRB 46757 was used to record receipt. Included Boiler spls, MM5, MUM location 5A. Chain of custody form & samples reconciled by (Sue &) Jan and Sue verifies

SM ~~Sample storage, preparation, analysis and custody procedures~~ labels on bottles. Most bottle caps are unlabelled. Tracked N5A MUM 727 spls. to QAP pg 5.2-30 diagram. All spls. accounted for. 07/28 N4 MM5 Impingers, probe rinses, Cyclones

SM ~~Additional Comments~~ and PRh-13 # 9, 10, 13 checked. All bags and bubble wrap protecting samples were carefully split with a (knife SM) knife. Pond and river water samples in quart amber bottles as well as Coal Run-off. ①

Recommendations QAPP pg 5.2-22 specifies 4-liter glass bottles for #9, 10 and 13 samples. Change to quart amber bottles must be addressed. Contd to 29 July 93

LABLST.05/93 Auditor's Signature and Date 30 July 93 Sandy M Anderson

① # 9 location called River Water on labels is referred to as Makeup Water, QAP pg 5.2-22

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LAB INSPECTION CHECKLIST

AUDITOR Sandy M. Ardern DATE 29 July 1993-02 Contd.

STUDY NUMBER SC93A214 SITE LOCATION Niles Station, Niles Ohio

TIME

STUDY PROTOCOL/QAPP

Lab Phase Inspected

Personnel Involved

Protocol/QAPP/SOP Requirements

Narrative Account N4-MM5-0728 trap samples were immediately transferred to Revco freezer (GI93219) in Room 6031 N-13-PRh-0729 has single entry of "no pH adj. pH already <2"; filter spl. N4MM5 07-28 and filter MUM5A (and 5B) 0727 attached to COC forms.

Sample storage, preparation, analysis and custody procedures Aldehyde, N4AHD0728, 40 ml amber Imp 1, 2, 3 (Red ID on lids) transferred to monitored refrig. (I85283) in room #6028. N4MM5 filters #1 and #2 0728 ESP Inlet transferred to freezer.

Additional Comments Four liter spls 9 and 10 for 0726 and 0728 placed in refrigerator. All samples received at 6P were properly transferred and stored. MUM and CN spls were transferred to Rm 7028 cold (40°F) storage

SMA Recommendations facility which is locked. Custody form originals are sorted by sample ID, put into binder and pages numbered consecutively. Originals remain

LABLST.05/93 Auditor's Signature and Date Sandy M. Ardern 30 July 1993

with custodian, copies go to analyst and technicians preparing spls. Initial pH and temp recorded >5 hours where required. All sample processing begins < 7 da holding time.

Contd. 29 July 02
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LAB INSPECTION CHECKLIST

AUDITOR Sandy M. Anderson DATE 29 July 1993-03 Cont'd.

STUDY NUMBER SC930214 SITE LOCATION Niles Station Niles, Ohio

→ Battelle Room 6028 TIME 6-8 P

STUDY PROTOCOL/QAPP QA/QC Plan DE AC22-93 PC 93251 07.16.93

Lab Phase Inspected Sample receipt custody transfer, storage

Personnel Involved Sue Champagne, Jan Satola

Protocol/QAPP/SOP Requirements QAP pg 5.1-27, 28

Recommendations from here to bottom of page:

Narrative Account

① N.13.PRL.0729 have four bottles with identical sample ids. Sequential samples must have sub-ID for traceability

② PRL sample in 40 ml vials for location 9 on 07/29 have identical IDs for 500 ml amber bottles. Need to differentiate

SM ~~Sample storage, preparation, analysis and custody procedures~~ for traceability and analysis ③ See recommendation re quart amber bottles rather than 4L amber on pg 01; ④ label / C of C discrepancies follow: a. N8PRS728 from hoppers read "1700 hrs" on

SM ~~Additional Comments~~ label and "1600 hrs" on C of C; b. 07.28 air heater ash from H3 is called "economizer ash" on labels

Spl 2-3 times 11:45 label 11:30 C of C
14:20 label 14:30 C of C
16:50 label 17:00 C of C
2-4 times 11:25 label 11:30 C of C
14:45 label 1430 C of C
17:30 label 1700 C of C

Recommendations

Coal sample N.1.PRS.727 2 bags for 07.27.93 no time recorded.

LABLST.05/93 Auditor's Signature and Date Sandy M Anderson 30 July 1993

→ All of above issues were relayed to the Field Sampling Manager by phone on 30 July 1993 by the QAO.

8515 7 28

LAB INSPECTION CHECKLIST

AUDITOR S M Anderson DATE 04 August 1993

STUDY NUMBER SC930214 SITE LOCATION Niles Station, Niles Ohio → Battelle Room 7243 TIME 740A

STUDY PROTOCOL/QAPP DE AC 22-93 PC 93251 07.16.93

Lab Phase Inspected PAH/SVOC - Liquid Samples Extraction

Personnel Involved Sue Champagne

Protocol/QAPP/SOP Requirements QAP 53-17-18

Narrative Account Method #3510 - Extraction Methods Separatory funnels all labelled 46707-9-XX. pH adjusted to <2. One liter samples, amber round bottles brought up from cold storage. QC samples prepared: MS, MSD (Pond) Duplicate (River Water), H_2O Blank

Sample storage, preparation, analysis and custody procedures Tracked N.9.PRL.730 Pond water, River Water, Trip Blank, Field Blank to lab and chain-of-custody forms

Additional Comments Added 1.0ml Surrogate Spike [(46399-77-05), labelled c name, date, storage temp]; Added 1.0ml Spiking Standard (46399-77-20), add $MeCl_2$, shake two minutes. Hood monitored (X92123) 04/13/93

Recommendations "Chad C." as sampler on C-of-C form insufficient for traceability. Discussed earlier c Tom Kelly. Called lab safety re. updated hood monitoring

LABLST.05/93 Auditor's Signature and Date Andy M Anderson 05 August 1993

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VERIFIED EXACT COPY
[illegible] 11.15.93

LAB INSPECTION CHECKLIST

AUDITOR S Mandum DATE 05 August 1993

STUDY NUMBER SCI 30203 SITE LOCATION Coal Creek / Miles Power Plant

TIME 10 A

STUDY PROTOCOL/QAPP DE AC 22-93PC93251, dated 21 June 1993

Lab Phase Inspected VOC - Canister Analysis GC/MS Systems Audit

Personnel Involved William Keigley

Protocol/QAPP/SOP Requirements QAPP p 4-3-6, 7; 4.2-3; 4.1-31

Narrative Account Canister checked for vacuum & pressurized to zero upon receipt (P-12 A in da of spl. received) of samples from custodian; GC/MS is calibrated c a 42-Component mix traceable NIST benzene std. (LL17305 - calib std). 42-comp. mix is injected into facility smog chamber, analyzed and ①

Sample storage, preparation, analysis and custody procedures Sample custodian delivers canisters after receipt + log-in to Bill Keigley who logs them into a facility spl. log book. Also has copy of orig. C-of-C forms, indicating trip spike(s) trip blank.

Additional Comments ①Contd. quantitated. Std. quantitation analysis report is placed into G285 study record books for traceability from original mixing by B. Keigley. Data is acquired on an HP5880 GC/FID with HP5970 MSD. HP computer system is

Recommendations HP ChemStation. Uses canister ID and Sample IDs as cross reference in logbook. Hard copy output transferred to M. Holden, as well as tape, which is retained for study duration.

LABLST.05/93 Auditor's Signature and Date Sandy Mandu 05 Aug 1993

Analyst checks data & performs reviews as: Calibration, sample. All data is retained. Ea samples data file includes: C-of-C copy, run log, hard copy output. Files run by daily sequence. After spls. are run, VOC canisters are transferred to Richard Smith for cleaning. ①
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[illegible] 11/15/93

LAB INSPECTION CHECKLIST

AUDITOR S M Andersen DATE 05 August 1993

STUDY NUMBER SC9302/4 SITE LOCATION Niles Station, Niles, Ohio

→ Battelle Rm 7331 TIME 130P, 325P

STUDY PROTOCOL/QAPP QA/QC Plan DE-AC22-93PC93251 Dated 16 July 1993

Lab Phase Inspected PAH/SVOC - Liquid Samples Concentration

Personnel Involved Sue Champagne

Protocol/QAPP/SOP Requirements QAP Pg 5.3-17

Narrative Account Concentrating samples (Kuderna-Danish) in Blue M Heated Water Bath; $MeCl_2$ extract combined acid/base. Thermometer measures water temperature at 65°, 70°. Concentrates to <1.0 ml → GC vial → analyst for storage and analysis at JN-4 facility (Battelle).

Sample storage, preparation, analysis and custody procedures Spl. 46707-09-04 K-D flask + receiver ampul labelled c Sample ID. C-of-C original form remains c sample custodian. Samples are kept under locked custody.

Additional Comments Micro-Snyder concentrations <1.0 ml are transferred to Wheaton Glass vials with teflon-faced silicon septa. Vials are labelled and labels covered with clear tape, teflon tape wrapped. Spls: extracts

SMA ~~Recommendations~~ stored in X42319 freezer, Rm 7345

Tracked 46707-09-03 Pond Water
N.9.PRL.730-04 River Water N.9.PRL.730-06 Field Blank
N.9.PRL.730-05 Trip Blank 46707-24-10 Water Blank

LABLST.05/93 Auditor's Signature and Date Sindy M Andersen 06 August 1993

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LAB INSPECTION CHECKLIST

AUDITOR S M Anderson DATE 11 August 1993

STUDY NUMBER SE93121A SITE LOCATION Niles Station, Niles Ohio → Rm 7343 TIME 830A

STUDY PROTOCOL/QAPP DE AC-22-93 PC 93251 07.16.93

Lab Phase Inspected Anion Analysis - Ion Chromatography

Personnel Involved Dave Vermillion

Protocol/QAPP/SOP Requirements QAP pg. 5.3-8,9; 5.1-16,17

Narrative Account Sample storage at 5°C #686-031 VWR, monitored on workdays; locked during off-duty hours. WPs - accuracy check same as Performance Evaluations on WP spls → (Cl, F, SO4) EPA → received by EPA → PE reports sent by EPA 2X/year; ICN's precision standards made from stock solutions

Sample storage, preparation, analysis and custody procedures ICN # assigned by Dave, cross reference to original chain of custody record and spl. description. Dave receives spls. and C-of-C copies and also signs original form. "Sample Status Sheet" reviewed regularly

Additional Comments Raw data acquired → analyzed → reported. ① Separate duplicates and spikes sheet. ② Standards and Calibrations lab pg 2. Bulk stds have exp. dates, kept 6 months. Phosphate made up fresh for

SMA ~~Recommendations~~ ea. batch. ③ Analysis Conditions describe column and eluents ④ Chromatograms are final output. File sent for QC review includes: Final Anion Report,

LABLST.05/93 Auditor's Signature and Date Sandy M. Anderson 11 August 1993

Summary Report, Calibration Plots, Duplicate and Spike Data, Standards Prep. Data, Analysis Conditions, Chromatograms.

Cont'd. 11 Aug. 93
891928

LAB INSPECTION CHECKLIST

AUDITOR S M Anderson DATE 11 August 1993 - 02 Contd.

STUDY NUMBER SC930214 SITE LOCATION Niles Station, Niles, Ohio

TIME 10:10A

STUDY PROTOCOL/QAPP

Lab Phase Inspected

Personnel Involved

Protocol/QAPP/SOP Requirements

Narrative Account 40 ml amber vial label checked & custody record after removal from locked refrig. Spl aliquot removed to Dionex vial. Analyst wears gloves for handling of samples. Vials marked c spl. ID and dilution of 4.95 ml DI H2O and 50 µl spl. c 50µl Gilson autopipette. Rinse pipet c "house" ①

Sample storage, preparation, analysis and custody procedures PRL (process waters) 1335-36, 1341-45 from 0728; 1345: spl, duplicate, and spike (0.2 ppm of ea analyte); 1:100 spl. dilution used. ~~Equip~~ error SMA 8/11/93

Additional Comments Equipment: Gilson Autopipette # C 486039, calib. before each use. Mettler AE760 # A61210, calib. due 09/93; weight set S/N 5386, calib. due Jan. 1994. Dionex # 13790; Balance record book line. Calibration record ④

SMA ~~Recommendations~~ ① DI water, also used as blank, plastic pipet and plastic Erlenmeyer. DI H2O put into flasks fresh ea day. Spl. dilutions performed directly into Dionex vials. Contd - 03

LABLST.05/93 Auditor's Signature and Date Sandy M Anderson 11 August 1993

④ contd. and weight certificates. Pipette calibration - weighs 50 µl H2O into plastic beaker. Weights were: 0.050, 0.051 and 0.051 mg.

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LAB INSPECTION CHECKLIST

AUDITOR S Mandeum DATE 11 August 1993 - 03 Contd

STUDY NUMBER SC930214 SITE LOCATION Niles Station, Niles, AG10

TIME

STUDY PROTOCOL/QAPP

Lab Phase Inspected

Personnel Involved

Protocol/QAPP/SOP Requirements QAP p 5.1-45

Narrative Account (B) Secondary dilution 4.5 ml H_2O and 0.5 ml of (A) from pg 02 this report. Was point & pixel sln. pipet for ea one of duplicate set and all sple was calibrated Gilson for 1:100 spl. dilution - Spl. vials are not mixed before aliquotting as analyst is looking for soluble materials only.

~~Sample storage, preparation, analysis and custody procedures~~ Stock anion std. used for spike; sple. capped c cap having built-in filter & mixed - was 5 ml Gilson autopipette (calibrated) for H_2O. Stds. stored in same refrig as sples. 10 µl ea std. spike used for 30 µl

Additional Comments total spike in 5.0 ml spl. Spiking c 100 ppm F^-, Cl^- and $SO_4^=$. Caps tightened, diluted & spiked sple mixed. Lrb p22, 23 describes prep. Working stds. in volumetric flasks made from stocks as described

SM ~~Recommendations~~ in study records. EPA Method 300 followed. first blank = refrigerated water blank → diluent blanks, rinse vials. Acquires data according to run schedule

LABLST.05/93 Auditor's Signature and Date Sandy Mandeum 12 August 1993

made up & analysis starts Contd. 11 Aug. 04

Standards and first blank loaded into autosampler. Analyst checks standards analysis as generated to check if all elements are < Rt limits

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LAB INSPECTION CHECKLIST

AUDITOR S M Anderson DATE 11 August 1993 - 04 Contd

~~STUDY NUMBER 5293124~~ SITE LOCATION Niles Station Niles, Ohio

~~TIME~~

~~STUDY PROTOCOL/QAPP~~

~~Lab Phase Inspected~~

~~Personnel Involved~~

~~Protocol/QAPP/SOP Requirements~~

Narrative Account Routine Maintenance ① clean cell + conduct. cell. Calib Std. 2X year or when analyst determines need ② Column change recorded. Conductivity Cell Calibration Standard = 1 mM KCl made up 1X year. Non-routine maintenance recorded in logbook. Dave has copy of ③ Work Plan

SM ~~Sample storage, preparation, analysis and custody procedures~~ ② EPA Method 300.0, December 1989, pp 01-04 Test Method for Detmn of Inorganic Anions in Water by Ion Chromatography. PE Std WP029 from EPA EMSL - uses 100 µl inj. volume. Method calls for

Additional Comments 10% QC spls. Recommended to Dave that spiking procs. for matrix samples be performed. Data can be qualified in the analytical report as 'not reported', 'saturated', etc. Peak Pro Version 2.1

Recommendations ① Add instrument ID specs. to record book ② Date and initial 'Final Anion Report' for traceability ③ Attach (tape) balance certificates in logbook

LABLST.05/93 Auditor's Signature and Date Sandy M. Anderson 12 August 1993

④ Add reference to use of EPA 300, Dec 1989, as guidelines
⑤ Add brief description of spl. prep to record book.

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LAB INSPECTION CHECKLIST

AUDITOR S Manders DATE 20 August 1993

STUDY NUMBER SN 302/4 SITE LOCATION Niles Station, Niles, Ohio

→ Battelle Room 6004 TIME 930A

STUDY PROTOCOL/QAPP DE-AC22-91PC 93251 07/16/93

Lab Phase Inspected PAH/SVOC Cleanup Liquid Samples - Filters

Personnel Involved Dave Davis, Jan Satola

Protocol/QAPP/SOP Requirements QAPP pg 5.3-13 to 16

Narrative Account Chromatography: deactivated silica gel - muffled 8 hr at 451°C - done fresh batch/day and approximately 10 g weighed onto column; Glassware ~~column~~ cleaning Cerra 8??, dilute acid, muffled afterwards; DI H_2O used for cleaning. Silica gel columns are wet-packed

Sample storage, preparation, analysis and custody procedures Lab 96688 used for PAH/SVOC tracking. Sample set 07-30 tracked. Sample code ID used as ~~cross~~ cross-reference. Dave Ogden extracts (ID #) → Dave O/ ~~Dave~~ Davis (new ID#) Chromaprep vials

Additional Comments freezer - monitoring 1X/week (SN971623) Preliminary study for fractionation determined volumes used and details for solvents using a validated procedure. Cont'd 20 Aug 0?

Recommendations Recommend calibrating freezer thermom; loose bottles into secondary containers to prevent possible breakage, padlocking freezer during non-working

LABLST.05/93 Auditor's Signature and Date Sandy Manders 23 August 1993

hours since laboratory is not locked.

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LAB INSPECTION CHECKLIST

AUDITOR S Manders DATE 20 August 1993 - 02 Cont'd

STUDY NUMBER SCI 90214 SITE LOCATION Niles Station, Niles, Ohio

TIME

STUDY PROTOCOL/QAPP

Lab Phase Inspected

Personnel Involved

Protocol/QAPP/SOP Requirements

Narrative Account Concentration vials stoppered, covered c teflon tape, labelled c sample ID, lab # date of prep, temperature/storage → Silica column is labeled c sample site ID → vials labelled c lab and spl. ID. Caps have teflon liners and are muffled (8 hrs/451°) <use.

SMA ~~Sample storage, preparation, analysis and custody procedures~~ Spl. loaded onto column → vial rinsed c hexane (1st wash discarded after packing column) → elution c MeCl2/hexane → amber bottles labelled c lab, spl. ID, type of fraction. Dilute fractions

Additional Comments are stored in hood at rt. until next step (Saturday). Spl. set ~~#4~~ 46688-43-8 thru 43-14; Niles 5B·F·730, 4, 5A, 5B are spl. IDs Cont'd 20 Aug c
Muffle oven - Blue M CN 7880F; S/N CW 566; hood X95526

Recommendations Extraction hood last monitored 04/13/93 - called safety re: monitoring face velocity in 6004 & determine hood efficiency

LABLST.05/93 Auditor's Signature and Date Sandy M Anders 23 August 1993

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LAB INSPECTION CHECKLIST

AUDITOR S M Anderson DATE 20 August 1993-03 Cont'd

STUDY NUMBER SC930214 SITE LOCATION Niles Station, Niles Ohio

→ Room 6004, 6031 TIME NA, 20 August 1993-0

STUDY PROTOCOL/QAPP (Samples were initiated for prep on 19 Aug. 1993)

Lab Phase Inspected

Personnel Involved

Protocol/QAPP/SOP Requirements

Narrative Account Sample concentration - Dave removes label from amber bottle, transfers to KD set-up. 2-3X rinse c $MeCl_2$. Add boiling chips. Wrap macro-snyder c foil, short rinse c $MeCl_2$

Sample storage, preparation, analysis and custody procedures Cyclone sample transfer from Dave Oyler / Melinda Hayes to Dave Davis - documented in 46688 for log-in then stored in freezer until fractionation initiated; transfer also documented in D. Oylers prep lab

Additional Comments Concentrated sample transferred to Chromaflex tube → spiked with internal standard then reduced c N_2 evaporator. Concentrated DCM fractions first then MeOH fraction. Blue M water bath 65° → 80° → 90°C

~~Recommendations~~ All glassware + boiling chips muffled; recleaned and remuffled afterwards c clean glassware only. MM5 samples from lab 46688 p 92

LABLST.05/93 Auditor's Signature and Date Sandy M Anderson 23 Aug 1993

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LAB INSPECTION CHECKLIST

AUDITOR L M Anderson DATE 20 August 1993 - A

STUDY NUMBER SC93I214 SITE LOCATION Niles Station, Niles, Ohio

→ Battelle TIME 330P

STUDY PROTOCOL/QAPP DE-AC22-93PC 93251 07.16.93

Lab Phase Inspected PAH analysis GC/MS

Personnel Involved Jane Chuang, Joe Tabor

Protocol/QAPP/SOP Requirements QAP P 5.1-19

Narrative Account FC-43 cell used for tuning filled ~1X/year. Calibration output record maintained. Two standards are run at beginning of day, every 3rd injection = std, and one run at end of day; FC-43 peak fit run at beginning of each day.

Sample storage, preparation, analysis and custody procedures "TSQ" Logbook has: sample ID, file ID lab reference number. File ID tracks to Instrument Run Log, then file → tape for data storage

Additional Comments Freezer for stds (R#386 4074) monitored every other day. Syringes are cleaned c toluene aspiration between each use Spl. analysis → J Tabor check IS peak → SOP = CHEM III-046; Equipment Finnegan MAT TSQ GC/MS

Recommendations → Jane QC's + generates Draft Report → V. Katona puts into spreadsheet → 3rd party QC review

Corrective Action: Joe → Jane who checks peak resolution, decides ①

LABLST.05/93 Auditor's Signature and Date Lindy M Anderson 20 August 1993

Run flow: FC 43 → std → std → spl. → spl. → spl. → stds

① to replace septum, break off front of column or to dilute the sample.

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LAB INSPECTION CHECKLIST

AUDITOR SMAnderson DATE 11 October 1993

STUDY NUMBER SC130214 SITE LOCATION Niles Station, Niles, Ohio → Battelle Rm 7249, 7228 TIME 210P

STUDY PROTOCOL/QAPP DE-AC22-93 PC93251 07.16.93

Lab Phase Inspected Dioxin/Furan Analysis GC/MS

Personnel Involved Mary Schrock

Protocol/QAPP/SOP Requirements QAP p5.1-20, 21

Narrative Account Spl. stored in freezer S/N 386-024 (Rm 7249); MS Log 46575 p83 for inst VG analytical HP5890A GC; 11-250J; Spl. removed from freezer, vortexed briefly then injected c separate spl. syringe. MS log has spl. file ID, GC/MS operating parameters; column is as specified ①

Sample storage, preparation, analysis and custody procedures Tracked spl. 46715-16-15, MMS Site 5A filter extract to MS logbook 46575 p83. Spl. custody transfer documented in Dioxin Lab Sample Logbook

Additional Comments ① in QAP p5.1-21. Five point recalibration performed on 10/07/93 (on MS log p.81). CONCAL is calibration point 03. Commercially available stds. (Cambridge Isotope) used. Dave Ogler is original standards custodian. Cont. 11 Oct 0.

Recommendations Checked c Mary + Karen Riggs re QAP p5.1-49 which implies that method blank will serve as lab and analysis blank. Clarified that method blank/spl. set is analyzed.

LABLST.05/93 Auditor's Signature and Date Sandy M. Anderson 11 October 1993

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LAB INSPECTION CHECKLIST

AUDITOR S. Mandern DATE 11 October 1993 - 02 contd

STUDY NUMBER SC93024 SITE LOCATION Niles Station, Niles, Ohio

TIME

STUDY PROTOCOL/QAPP

Lab Phase Inspected

Personnel Involved

Protocol/QAPP/SOP Requirements

Narrative Account Spl. flow = window mix and column performance check (both commercially purchased), run as a single injection → calibration point 03 → decane blank → spls. as method blank (once/set), sample, matrix spike, spl. Cal. pt. 03 run at beginning and end of day

Sample storage, preparation, analysis and custody procedures MS log: MS file ID, lab ID, spl. ID for mass sequence, injection volume, and clock time for injection; Cal. Standards window & perf. mix stored in monitored, locked freezer (I-75025)

Additional Comments M. Shrock and J. Tabor performing dioxin analyses. JT does integrations (data analysis) and Mary enters data into spreadsheets which are transferred to Assistant Project Manager for final review

SMA Recommendations ~~Recommendations~~ To SEQ computer validation performed 03/01/93, 07/07/93 (by M. Shrock) and both passed

LABLST.05/93 Auditor's Signature and Date Sandy M. Andrews 11 October 1993

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APPENDIX C

<u>SAMPLING PROTOCOL</u>

SAMPLING PROTOCOL

C-1. Introduction

The purpose of this Appendix is to summarize important aspects of the field sampling effort at Niles Station that may not be adequately covered elsewhere. The actual schedules and sample recoveries achieved in the field are described in sections 1 through 3 of this report. This Appendix provides further detail on the procedures used in sampling, recovering, and storing samples from flue gas, solid, and liquid streams. This information is intended to supplement that provided in the QAPP for this project.

C-2. Reagent and Materials Preparation

The sampling conducted at Niles Station required a variety of chemical reagents and sampling materials, which were prepared or provided either by Battelle or by Battelle's subcontractors. All of the chemical reagents needed for flue gas sampling and sample treatment were prepared by Battelle, and distributed to Chester Environmental sampling personnel as needed. The purpose of this approach was to minimize sampling variance by using reagents from a single source. The list of reagents included acidified peroxide and permanganate for the Multi-Metals trains, carbonate/bicarbonate solution for the anion trains (Method 26A), 0.1 N H_2SO_4 for ammonia collection, 0.1 M NaOH for cyanide collection, and acidified 2,4-dinitrophenylhydrazine (DNPH) for aldehyde collection. These reagents were made up on-site from high purity starting materials, including deionized water, or were prepared from concentrated stock solutions brought from Battelle, when reagent stability made that approach appropriate. All reagent solutions were made up fresh on the day of sampling and distributed to Chester personnel.

Various rinse solutions were also brought to the site or made up by Battelle, for use in recovering samples from the various trains. Those brought to the site were deionized water, acetone, acetonitrile, and 50/50 methanol/methylene chloride. Rinse solutions made up at the site were 0.1 N HNO_3 and 8 N HCl. These solutions were supplied to Chester staff as needed.

Sampling materials were provided both by Battelle and by subcontractors. Materials provided by Battelle were Summa polished sampling canisters for VOC's, filters for all flue gas sampling runs except the HEST, and cleaned XAD resin for all SVOC sampling by Modified Method 5. The XAD was obtained and cleaned by Battelle, and was used to fill sampling glassware of different designs for Battelle and Chester. The filters provided by Battelle included 87 mm diameter for Battelle's flue gas sampling, 104 mm diameter for Chester's hot flue gas sampling, and 203 mm x 254 mm (8 in. x 10 in.) for Chester's PSDS sampling. All these filters were high purity quartz fiber. Filters used for SVOC sampling were muffled and stored in muffled aluminum foil before use. Filters used for Multi-Metals and particulate mass measurements were weighed under constant conditions before shipment to the field. Battelle also supplied pre-cleaned containers for most of the flue gas and solid/liquid samples.

Other sampling materials were supplied by subcontractors. Chester supplied pre-cleaned VOST traps for use by both Chester and Battelle, and provided HEST carbon-impregnated filters and associated quartz particulate pre-filters for both groups. Chester provided cascade impactors and the necessary stage components for particle size determinations at Locations 5a and 5b. Zande Labs provided pre-cleaned 40-ml vials for headspace-free collection of liquid samples for VOC analysis.

C-3. Sample Preparation

The Battelle and Chester field sampling teams prepared their own respective sampling trains using the reagents and materials described above. Within each of the Battelle and Chester field teams, a single staff member was designated the Sample Recovery Leader. That person, and only that person, directed and approved the preparation and recovery of sampling trains. Each group used their own laboratory facilities on-site, as described below:

- Battelle's field laboratory is a 40-foot air conditioned semi-trailer equipped with a side entrance door and an electrically operated platform lift at the rear double doors. The trailer accepts 100 A of 125 V/250 V AC power by hardwiring to a transformer or switch box. This trailer served as the primary contact point for Battelle and Chester staff, and was used for meetings among project personnel to review the previous day's activities and plan for the current day. Such meetings were especially necessary on the 6 sampling days, but were useful in the setup and shutdown phases of the field effort.

- Two 28-foot rental trucks equipped with side entrances were used by Battelle staff for preparation of flue gas sampling equipment and for recovery of some samples. The two trucks were equipped with tables, storage areas, and a desk for equipment setup, and sample recovery. One of these trucks was used as the sample recovery area for aldehyde samples only. This arrangement minimized contamination of aldehyde samples by acetone used in other activities.

- Chester Environmental's field laboratory was a laboratory trailer approximately 15 feet long, and equipped with lights, air conditioning, storage, and work areas. The laboratory trailer was used by Chester for preparation of sampling equipment, cleanup, sample recovery, and sample documentation tasks.

The facilities described above were positioned close to one another near the stack and the SNOX demonstration project at Niles Station. That location was roughly centrally located among the various flue gas and process sampling locations. In addition, two commercial compressed gas tube trailers were positioned near the base of the Boiler No. 2 stack. Those trailers were obtained by Chester, and supplied the N_2 and O_2 needed as diluent gas in the plume dilution sampling at the stack.

Written procedures for reagent and train preparation were provided to field staff, and were posted in the train preparation areas of the Field Facilities. Copies of those documents, which included sample recovery as well as preparation procedures, are included at the end of this Appendix. All sampling reagents and trains were prepared under the direction of the Sample Recovery Leader. Every flue gas sampling train was accompanied by a chain-of-custody form specific for that sample and sampling location, from the moment the train was assembled. That custody form remained with the train throughout sampling, and was returned to the field laboratory with the train once sampling was completed. That same form was then used during sample recovery and documentation procedures.

C-4. Sampling Methods

Table C-1 presents a summary of the chemicals measured, the type of samples in which each chemical was measured, and the sampling methods used for each.

TABLE C-1. SUMMARY OF REQUIRED MEASUREMENTS AND SAMPLING METHODS USED TO ACHIEVE THEM

Measurement	Type of Sample	Method
Volatile Organic Compounds (VOC)	Flue Gas	Summa Canisters[a]
	Flue Gas	Volatile Organic Sampling Train (VOST)
	Liquid	Process Sample Collection
Semivolatile Organic Compounds (SVOC)		
Polycyclic Aromatic Hydrocarbons (PAH)	Flue Gas (Vapor)	Method 23/Modified Method 5
and Other SVOC	Flue Gas (Particulate)	Method 23/Modified Method 5
	Solid	Process Sample Collection
	Liquid	Process Sample Collection
Polychlorinated Dibenzo-p-Dioxins and	Flue Gas (Vapor)	Method 23/Modified Method 5
Dibenzofurans (PCDD/PCDF)	Flue Gas (Particulate)	Method 23/Modified Method 5
Volatile Elements (Hg, As, Se)	Flue Gas (Vapor)	Hazardous Element Sampling Train (HEST)
Elements	Flue Gas (Particulate)	Method 29
	Flue Gas (Vapor)	Method 29
	Solid	Process Sample Collection
	Liquid	Process Sample Collection
Anions (F^-, Cl^-, $PO_4^{=}$, $SO_4^{=}$)	Solid	Process Sample Collection
	Liquid	Process Sample Collection
	Flue Gas (Particulate)	Method 26A/CARB 421
HCl, HF	Flue Gas (Vapor)	Method 26A/CARB 421
Ammonia	Flue Gas (Vapor)	Impingers, APHA 401
	Liquid	Process Sample Collection
Cyanide	Flue Gas (Vapor)	Impingers, APHA 808
	Liquid	Process Sample Collection
Aldehydes	Flue Gas (Vapor)	TO-5, APHA 122
	Liquid	Process Sample Collection
Radionuclides	Solid	Process Sample Collection
	Flue Gas (Particle)	Filter from Ammonia/Cyanide Train

TABLE C-1. (Continued)

Measurement	Type of Sample	Method
Carbon	Solid	Process Sample Collection
	Flue Gas (Particle)	Filter from Ammonia/Cyanide Train
Particle Size Distribution	Flue Gas (Particle)	Impactors
	Flue Gas (Particle)	Cyclones with Method 29
	ESP Ash	Process Sample Collection
Moisture, Heat Content, Ultimate/Proximate	Boiler Feed Coal	Process Sample Collection

(a) On Method 23 train.

The sampling methods used were detailed in the QAPP for this study. Brief descriptions of the sampling methods are as follows:

USEPA Method 29 (Draft June, 1992) - Multiple Metals. Method 29 is designed to determine emissions of metals from stationary sources. In Method 29, flue gas is withdrawn isokinetically from the source, with particulate emissions collected on a heated quartz filter and gaseous emissions collected in a series of chilled impingers. The series of impinger consists of two impingers containing a solution of dilute nitric acid and hydrogen peroxide, and two impingers containing a solution of dilute potassium permanganate and sulfuric acid.

A series of two glass cyclones preceded the pre-weighed quartz filter at the ESP inlet to provide size cuts of > 10 μm, 5-10 μm, and < 5 μm in the collected particulate matter. These cyclones were located in the heated sampler box along with the particulate filter. Thus the 10 μm and 5 μm cyclones replaced the single 10 μm cyclone normally used in the Method 5 type train.

Method 29 sampling at the ESP inlet was modified to include the use of a flexible, heated, Teflon sample line connecting the probe to the heated cyclones and filter. The flexible heated line, which allowed the vertical sampling required at that location, was made of 1/2 in. diameter, thick-walled, Teflon tubing and contained a temperature monitor. An empty impinger was used in the train for condensate drop-out.

USEPA Method 26A - Particulate Matter, Hydrogen Chloride, Hydrogen Fluoride. Sampling was conducted along the general procedures of EPA Method 26A, with adaptations to the guidelines of California Air Resources Board (CARB) Method 421 in the collection solution employed. Method 26A is designed to determine particulate matter, and hydrogen halides in the absence of other chloride-containing volatile species. It is suitable for combustion sources where the primary source of chloride is the dissociation of chlorinated organic compounds. In the present study this method was be used to determine HF/HCl and their corresponding particulate anions, as well as particulate $SO_4^{=}$ and PO_4^{3-}.

A sample of flue gas is withdrawn isokinetically from the source, with particulate emissions collected on a heated filter and gaseous emissions collected in a series of chilled impingers containing a solution of sodium carbonate (1.8 mM) and sodium bicarbonate (1.7 mM). The method was used in this study in a single-point, nontraversing mode. The use of carbonate/bicarbonate solution as the collecting medium for HCl and HF followed the guidelines of CARB 421. The solution was prepared by a 1:1000 dilution of stock solution in the field. The same solution was used for rinsing of the probe and filter holder after sample collection. An empty impinger was used at the front of the chilled impinger train to collect condensed water from the stream. The collected condensate was saved as a sample fraction for chemical analysis.

USEPA Method 23 - Semivolatile Organic Compounds. Method 23 is designed to determine specifically dioxins and furans. In this study, Method 23 was adapted, according to Modified Method 5 guidelines, to measure polycyclic aromatic hydrocarbons (PAH). Thus Method 23 as referred to in this document is a modified method for measurement of the following types of chemicals, which collectively are called semi-volatile organic compounds (SVOC):

- Polycyclic Aromatic Hydrocarbons (PAH)
- Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans (dioxins/furans).

In addition, whole air samples were collected from the Method 23 train in SUMMA polished canisters, to determine volatile organic compounds (VOC). Samples for VOC were taken with both SUMMA canisters and VOST (volatile organics sampling train) for comparison of the two methods.

Glass cyclones were used in the Method 23 train as described above for the Multi-Metals train. At the ESP inlets the method employed a flexible heated Teflon sample line connecting the probe to the heated filter. The flexible heated line, which allowed the vertical sampling required at this location, was made of 1/2 in., thick-walled, Teflon tubing and contained a temperature monitor.

The SUMMA samples were taken directly into evacuated stainless steel canisters. The samples were taken from a tee in the Method 23 train between the condenser and the XAD-2 cartridge for the Chester samples, and were taken from a tee upstream of the integral condenser/XAD unit in the Battelle train. Each canister was equipped with a manual valve to maintain vacuum until sampling is initiated. A flow orifice was sized and installed in the sampling line (Teflon) between the tee and the canister valve, to provide a time integrated sample. The orifice was sized to allow the canister to fill over a one-half hour period. The Chester tee fitting was designed so that water condensing in the main air flow to the XAD-2 cartridge was separated by gravity from the small air flow (approximately 200 cm^3/min) flowing to the canister. This arrangement prevented water from clogging the flow orifice in the canister line. In the Battelle train, a glass midget impinger containing hydrogen peroxide solution was placed in an ice bath, and served to condense out moisture and remove SO_2 in the flow line upstream of the orifice. Each canister connection had a compound pressure/vacuum gauge attached. This gauge was used to measure the initial canister vacuum, monitor canister pressure during sampling, and record the final canister pressure after sampling. Three canister samples were taken (approximately simultaneously with three VOST samples) on each organic sampling day.

VOST. VOST samples for volatile organic analysis were taken with a Graseby-Nutech 280 Volatile Organics Sampling Train (VOST), or equivalent. Sampling was conducted consistent with the procedures of SW-846 Method 0030 which provides for the collection of volatile organic compounds by adsorption onto Tenax and Tenax/charcoal sorbents, and with the guidelines stated in the VOST manual (Graseby-Nutech, Durham, NC). The standard VOST consists of a glass-lined probe followed by an isolation valve, a water-cooled glass condenser, a sorbent cartridge containing Tenax (1.6 g), an empty impinger for condensate removal, a second water-cooled glass condenser, a second sorbent cartridge containing Tenax and petroleum-based charcoal (3:1 by volume; approximately 1 g of each), a silica gel drying tube, a calibrated rotameter, a sampling pump, and a dry gas meter. The gas pressure during sampling and for leak-checking was monitored by pressure gauges which are in line and downstream of the silica gel drying tube. In this study, the Tenax/charcoal sorbent traps were augmented with a combination of modern carbon-based sorbent materials (Carbosieve, Supelco, Inc.). This approach enhanced collection and recovery of a variety of volatile organics from the flue gas streams.

Each VOST run consisted of three samples, each of which comprised a pair of traps in the VOST system. The three samples were taken over periods of 5, 10, and 30 minutes, at a flow rate of 0.5 L/min. Each VOST sample was run during the same time period as the SUMMA canister samples collected from the Method 23 train.

Impinger Sampling. Sampling for gaseous aldehydes, cyanide, and ammonia was conducted using a series of impingers downstream of a Method 26A type train operating at a single point (i.e., nontraversing) in the flue gas flow. The front half of the train consisted of a glass nozzle, glass heated probe, and a heated quartz fiber filter. The back half of the train was a separate set of impingers prepared for each of the analytes listed above, and changed out sequentially over the course of each sampling day at intervals corresponding to the appropriate sampling times.

The aldehyde samples were taken after the general provisions of EPA Methods 0011 and TO-5 and APHA Method 122 (Aldehydes in Ambient Air and Source Emissions). The sample were collected nonisokinetically, and the filter was not analyzed for aldehydes. The first impinger was an empty condensate collector, and the next two impingers contained an acidic 2,4-dinitrophenylhydrazine (DNPH) solution in which aldehydes in the sample are converted to form stable DNPH derivatives. These were followed by a silica gel impinger and a pump and metering box. The aldehyde samples were run for 1 hour at a flow rate of 1.0 L/min.

The sampling train used for ammonia and cyanide contained a filter to collect material for radionuclide and residual carbon analysis. Sampling was isokinetic at a single point. The cyanide samples were taken after the general provisions of APHA Method 808 (Determination of Cyanide in Air) with an impinger train, as those described above, but containing a dilute sodium hydroxide solution to collect gaseous cyanide and retain it in ionic form. The sampling time was about 1 hour.

The ammonia sample was also taken with an impinger train after the provisions of APHA Method 401. The train was similar to those described above, but contained a dilute sulfuric acid solution. Ammonia in the sample gas is converted and retained in the impinger solution as ammonium sulfate. The sampling time was about one-half hour.

The need for analysis of the filter in Method 26A for F^- and Cl^- dictated a large sample flow for that method. Replacing impingers for HF and HCl with those for ammonia, and cyanide readily adapted Method 26A to sampling those constituents as well, but required use of standard glassware and reagent volumes. Consequently, sampling for gaseous ammonia and cyanide employed full-size Method 5 glassware, with sample flow rates of 10-15 L/min. A single particulate filter was used throughout the sampling of ammonia and cyanide in sequence, to maximize the particulate sample collected for radionuclide and residual carbon analysis.

HEST. The Hazardous Element Sampling Train (HEST) was used to determine volatile elements at the flue gas sampling locations. The HEST sampler consists of a filter pack with a stainless steel support screen, and three 47-mm filters. The air flow entering the HEST sampler first encountered a quartz filter for particle collection, followed by two charcoal impregnated filters for collection of volatile elements (arsenic, mercury, selenium). The first impregnated filter is for collection of the volatile elements, and the second allows checking for breakthrough. Because only volatile elements are of interest, the HEST was used for nonisokinetic, single point sampling.

Particle Size Determination. Pilat Mark III Source Test cascade impactors were used to determine particle size distributions in both hot and dilute sampling at the ESP outlet, i.e., at Locations 5a and 5b in the stack. The impactors had an inlet, seven impactor stages, and a back-up filter. All impaction stages and the filter were glass fiber mat. The impactor performs aerodynamic sizing by routing the sample through a series of bends of increasing sharpness and jets of diminishing diameter. As the gas passes through the impactor jets, aerosol particles, which due to inertia cannot follow the gas flow stream, land on glass fiber filters attached to back-up plates. The smaller particles remain in the gas stream, continuing on to the next stage. With each successive stage, the mean diameter of the particles decreases down to the final back-up filter, which screens out all remaining particulate. The actual aerodynamic cut size per stage depends on the velocities of the gas through the impactor.

Cascade impactors were used at the ESP outlet at Niles Boiler No. 2, in both hot and dilute sampling modes.

A summary of the testing methodology follows:

1. Isokinetic sampling rates, nozzle size and sampling times were calculated based on preliminary velocity, temperature and moisture characteristics.

2. The units were assembled and sealed in a clean area, transported to the sampling location, attached to the sampling probe and train, and tested for leakage at 15 in. Hg vacuum.

3. The sampling head was then pointed downstream for a minimum of 10 minutes, to allow the assembly to warm to stack temperature. The assembly was then turned 180 degrees to begin sampling. The sampling consisted of a single point sample, collected isokinetically at a point of average flue velocity.

4. After the sample was collected, the sampling head was removed from the stack, disconnected from the sampling probe, sealed and transported to a clean area for disassembly and sample recovery. Collection plate filters were removed stage by stage using tweezers and placed in separate, labelled petri dishes. The jet stages were examined and any blocked jets cleaned.

5. The petri dishes were sealed for transport to Chester's laboratory for gravimetric determinations. The sampling head was then reassembled for the next test.

Hot Versus Dilute Sampling. Sampling was conducted at the ESP outlet (Boiler No. 2 stack) on both hot and diluted stack gases. Although the methods described above were used in both modes of sampling, substantial differences exist in the way the sampling was carried out. The following is a description of those sampling efforts.

The hot stack sampling was conducted using the four 3-in. ports arranged at 90 degree intervals around the circumference of the stack. Methods 29, 23, and 26A sampling were conducted isokinetically with traversing of stack diameters conducted for Methods 29 and 23.

Other gas sampling methods (HEST, VOST, aldehydes) were operated in nonisokinetic, single-point mode at the hot stack locations, since only volatile constituents are of interest.

All of the dilute gas samples at the ESP outlet were taken with Chester's plume simulating dilution sampler (PSDS). The flue gas sample was removed from the stack through a single port, without traversing (traversing is prohibited by the size and configuration of the PSDS and peripherals). After dilution, mixing and retention, particle samples were collected onto an 8 x 10 in. quartz filter for various chemical analyses, and into a cascade impactor for size distribution by mass. Gas phase samples were taken from a common gas sampling manifold following the 8 x 10 in. particle filtration.

The major components of the PSDS are the inlet nozzle, transfer tube, mixing and aging (dilution) chamber, and the various particle and gas phase sampling apparatus. All of the wetted surfaces in the sampler are stainless steel, Teflon, or Viton.

A conventional Method 5 buttonhook sampling nozzle was installed on the transfer tube to extract a hot flue gas sample isokinetically. The nozzle was sized on-site to match sample flow with stack gas velocity within the targeted range of diluent gas rate (~20-25 scfm) and dilution ratio (~25-35:1).

The sample entering the inlet nozzle passed through the transfer tube and the dilution chamber for dilution, aging, and collection, along with secondary particles formed in the dilution process. The transfer tube was maintained at stack temperature to prevent premature condensation. An S-type pitot tube and a thermocouple were installed on the transfer tube to monitor stack gas velocity and temperature. The flow rate through the transfer tube was established by the difference between the total stack pressure at the inlet nozzle and the static pressure in the dilution chamber. This pressure difference, monitored with a Magnehelic gauge installed between the upstream port of the pitot and the dilution chamber, is referred to as chamber pressure. The chamber pressure-flow relationship is established by calibration of the nozzle/transfer tube assembly as an integrated unit. The operating chamber pressure was determined on-site using this calibration with the appropriate temperature and pressure corrections for the actual stack conditions encountered.

The dilution chamber facilitates mixing of the flue gas with dilution gas, cooling, and aging of this mixture to simulate the dilution processes occurring in a plume, and distribution of the aged mixture to the various sampling devices. The chamber sections can be configured to affect variety of dilution, aging, and sampling schemes. The chamber flows were balanced by throttling the dilution gas (supplied under pressure) as required to establish the operating chamber pressure (for the specified flue gas flow rate through the transfer tube) while maintaining the necessary sampling device flow rates (withdrawn under vacuum).

The dilute gas conditions result from the mixing of the flue gas with the dilution gas, at a dilution ratio of 25:1 or more. Accordingly, the composition of the dilution gas is of controlling significance. The purpose of the dilution gas is to simulate atmospheric plume cooling and condensation, while minimizing artifact formation and without adding background contamination.

The targeted dilute sample gas conditions were near ambient temperatures and <30 percent relative humidity (RH), after 2 seconds residence time. These conditions were considered appropriate to provide adequate condensation and equilibration of analyte species and to minimize artifact formation due to acidic condensate on sample substrates. The residence time was achieved by configuring the dilution chamber. In order to achieve the temperature and relative humidity objectives, the dilution gas was delivered at ambient temperature and virtually bone dry, i.e., less than 5 ppm.

A cryogenically pure mixture of 20 percent oxygen/80 percent nitrogen (by volume) was used for the dilution gas. Because both component gases were of cryogenic origin, maximum dryness and organic background purity were achieved. The dilution gas was delivered pre-mixed to the test site in high volume (40,000 scf) compressed gas tube-trailers. A delivery manifold on the trailers provided pressure regulation (50-60 psig) and activated carbon filtration of the gas prior to delivery to the sampling location. The gas was delivered to the sampling location through a Teflon line to a control manifold connected to the inlet of the dilution chamber. The control manifold consists of a rate control valve, temperature and pressure instrumentation, and final HEPA filtration.

The dilution sampler was operated according to Chester's PSDS Standard Operating Procedure, as modified to accommodate the special requirements of this project. This document provided the calibration, calculation, and operating procedures to establish and maintain the required balance of sample and dilution flows. The appropriate operating points were established on-site, using a calculation spreadsheet and a portable computer. The spreadsheet contained calibration constants for all of the appropriate dilution sampler components (transfer tube/nozzle combinations, flow metering orifice) and accepted operator inputs for actual ambient, stack, and sampling parameters. At start-up, initial operating points were calculated using estimated default inputs. Over the course of each test, the spreadsheet was updated with actual operating conditions and the appropriate operating points maintained. The operating parameters were manually recorded at 15-minute intervals on special field data sheets which were designed for this project.

<u>Particle Sampling</u>. Dilute particle samples were collected with an 8 x 10 in. high-purity quartz fiber filter and with a seven-stage source cascade impactor from two parallel circuits exiting the dilution chamber.

Because of the low concentrations after dilution (< 1 mg/dscm), particulate samples were collected for as long as the dilution sampler operated on any given sampling day. This was typically 8-10 hours, as required to complete the daily sampling schedules. Because of the combination of low concentration and low flow rate, the cascade impactor was operated for 2 consecutive days without changing substrates. This provided for three runs of 16 to 20-hour duration.

<u>Gas Phase Sampling</u>. All of the dilute gas phase samples were taken from a common gas sampling manifold installed downstream of the 8 x 10 in. filter between the metering orifice and the blower. Samples were taken for the same analyses as for the hot gas phase samples, with apparatus of essentially the same description. but using only the back-half of the respective train. The dilute sampling rates were higher than the hot sampling rates, to maximize the volumes of stack gas available within comparable simultaneous sampling times. Full-size impingers and metering systems were used.

<u>Process Stream Sampling</u>. Process samples were collected by grab sampling from the various process locations using appropriate collection methods and containers. Since some of the solid process samples were collected hot, the safety of the personnel collecting samples was of primary importance. Battelle staff called upon Niles staff for assistance as needed in any instance where safety was a concern.

Coal samples were collected by Niles staff and composited on-site by ASTM methods. Pre-cleaned containers of appropriate sizes and materials were used by Battelle staff for collection of other solid samples (ESP ash, air heater ash).

Bottom ash samples were collected manually by grab sampling using a cleaned scoop. The collected samples were allowed to cool in stainless steel containers before being placed into glass containers.

Collection of liquid process samples differed from that of solid samples in that multiple samples of different sizes were collected in different containers for different purposes. Aliquots of each liquid sample were collected directly into 40 mL glass vials without headspace, for subsequent VOC analysis. In addition, separate glass bottles were used to collect aliquots for elements, ammonia, and cyanide. Each of these aliquots was treated appropriately for sample preservation, e.g., reduction of pH to < 2 to preserve NH_3 for analysis. Finally, a large (≈ 4 L) aliquot was collected in a glass bottle for SVOC and anion analyses.

C-5. Sample Storage and Recovery Procedures

Flue gas sampling trains were returned to the field laboratories after sampling for sample recovery by the Sample Recovery Leader. Sample recovery areas were off-limits to all but those staff involved in the actual preparation, recovery, and documentation of samples. Sample recovery was generally done after the completion of all sampling for the day, and after sampling staff had left the site. This further minimized interference in the sample recovery process. Sample recovery procedures were set out in single-sheet protocol forms, that detailed the train preparation and sample recovery steps for each train. These forms were distributed to sampling staff and were posted at each sample recovery area in the field laboratories. Copies of those forms are included at the end of this Appendix.

Samples recovered typically involved several portions or fractions of various types, or intended for various purposes. Samples were preserved and stored under conditions appropriate for the sample type. Table C-2 summarizes the preservation and storage conditions for various samples. Sample preservation consisted of adjustment of pH for liquid or impinger samples. Most samples were refrigerated in the Battelle field facility (4 C), or were stored at room temperature in shipping boxes ready for transfer to the analytical laboratory. The Modified Method 5 (Method 23) particulate filters were stored on dry ice in the field to maintain the -78 C temperature indicated.

TABLE C-2. PRESERVATION AND STORAGE REQUIREMENTS

Sample	Analysis[a]	Preservation Requirements	Storage Conditions	Holding Time
Bulk Solid Samples	Elements, F-C-P	None	Room Temperature	30 days
	SVOC	None	Room Temperature	30 days
	U/P, RAD	None	Room Temperature	30 days
Liquid Samples	Dissolved trace elements	HNO_3 to pH <2	Room Temperature	30 days
	Total trace elements	HNO_3 to pH <2	Room Temperature	30 days
	Anions	None	4°C	14 days[c,d]
	VOC	No headspace	4°C	14 days[c]
	SVOC	None	4°C	14 days[b,c]
	CN	NaOH to pH >12	4°C	14 days
	NH_4	H_2SO_4 to pH <2	4°C	14 days
Method 29 Train				
Impinger Solutions	Trace Elements	HNO_3 to pH <2	4°C	30 days
Particulate Filter	Trace Elements	None	Room Temperature	30 days
Method 23 Train				
XAD-2 Resin	SVOC, PCDD/PCDF	None	4°C	28 days
Particulate Filter	SVOC, PCDD/PCDF	None	-78°C	28 days
Summa Canister	VOC	None	Room Temperture	2 days[c]
Aldehyde Impinger Train	Aldehydes	None	4°C	28 days
HEST Samples	Hg, As, Se	None	4°C	6 months
Ammonia Train Impinger Solutions, Liquids	Ammonia	None	4°C	14 days
CN Train Impinger Solutions	CN	None	4°C	28 days
Method 26A Train Impinger Solutions	HF, HCl	None	4°C	28 days
Method 26A Train Filter	$SO_4^=$, $PO_4^≡$, F^-, Cl^-			
VOST Cartridges	VOC	None	4°C	14 days

(a) F-C-P = Fluoride, Chloride, Phosphate
SVOC = Semi-volatile Organics
VOC = Volatile Organics
RAD = Radionuclides
PCDD/PCDF = Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofuran.
UP = Ultimate/proximate coal analyses.
C = Carbon.
CN = Cyanide.
NH_4 = Ammonia.

(b) Extracted within 14 days, analysis within 40 days of extraction.

(c) Samples were returned to Battelle within 24 hours after collection in the field.

(d) Liquid samples were analyzed as soon as possible for phosphate to minimize degradation of this analyte in these samples.

Although as Table C-2 indicates holding times for the collected samples were quite long, in practice some samples were returned to the analytical laboratories immediately after collection by daily express shipment from the plant site. Those samples included liquid samples for anions, VOC, and SVOC, Summa canisters, VOST cartridges, and (when space was available) impinger samples from flue gas trains. Other samples were returned to Battelle with the field facilities at the end of the study. Chain-of-custody forms accompanied all samples at all times during storage on-site at Niles, and during shipment. A Battelle staff member was designated to serve as Chain-of-Custody officer at Battelle for samples sent back or brought back from the field study. That staff member had complete control over access to samples at Battelle, and distributed samples to the appropriate analytical staff only after cross-checking of chain-of-custody forms.

C-6. Sampling QA/QC

Quality assurance activities in field sampling included collecting samples of all reagent and rinse solutions, including deionized water, for use as reagent blanks. Method blanks were also collected, by preparing a complete sampling train, exposing it to the normal handling and transport procedures used before and after sampling, and recovering the train without sampling of flue gas. This procedure exposes the train to potential sources of background contamination as in normal sampling. In addition, specific QC procedures specific to each of the sampling methods were used. Those specific procedures are described briefly below:

QC Checks for Velocity/Volumetric Flowrate Determination. Prior to flue gas sampling, volumetric gas flow rate data were collected at the flue gas sampling locations, using the procedures specified in EPA Method 2. Quality control procedures were as follows:

- Visually inspect the S-type pitot tube or standard pitot tube before and after sampling.
- Leak-check both legs of the pitot tube before and after sampling.

- Check the number and location of the sampling traverse points before taking measurements.

- Clean and check inlet tubes periodically and clear ash from impact side of pitot tube as necessary.

<u>Quality Control Procedures for Moisture Determination</u>. The moisture content of the gas streams was determined using the technique specified in EPA Method 4. However, the actual moisture sampling was conducted as part of Methods 23, Method 5, and Method 29 sampling procedures at the flue gas locations. The following internal QC checks were performed as part of the moisture determinations:

- The volume of impinger contents was measured by weighing to the nearest gram before and after sampling.

- The sampling train (including impingers) was leak-checked before and after each run.

- Ice was maintained in the ice bath throughout each run.

- The volume of water in the collection bottle, into which water from the first impinger was periodically drained, was measured by weighing to the nearest gram.

<u>Quality Control Procedures for Flue Gas Sampling Methods</u>. The following pretest QC checks were conducted for all flue gas sampling methods:

- All sampling equipment was thoroughly checked to ensure clean and operable components.

- Equipment was inspected for possible damage from shipment.

- The oil manometer or Magnehelic gauge used to measure pressure across the pitot tube was levelled and zeroed.

- The pitot tubes and connecting tubing were leak checked

- The temperature measurement system was visually checked for damage and operability by measuring the ambient temperature prior to each traverse.

In addition to the general QC procedures listed above, QC procedures specific to each sampling method were also incorporated into the sampling scheme. These method-specific procedures are discussed below.

Quality Control Procedures for Method 29. EPA Method 29 was used to sample for vapor phase and particulate elements. The following quality control procedures were followed:

Prior to Start of All Testing

- The trains were assembled in an environment free from uncontrolled dust.
- Each sampling train was visually inspected for proper assembly.
- All cleaned glassware was kept closed with tightly closed ground glass caps or Teflon tape.
- All filters were stored in a precleaned glass petri dish sealed with Teflon tape.
- Pretest calculations were performed to determine the proper sampling nozzle size.

Prior to Testing Each Day

- The number and location of the sampling points were checked before taking measurements.
- The sampling nozzle was visually inspected.
- Each leg of the pitot tube was leak-checked.
- The entire sampling train was leak-checked.

During Testing Each Day

- The roll and pitch axis of the pitot and the sampling nozzle were properly maintained.

- The train was leak-checked before and after a run, if the train was opened for any reason, and if a filter change took place.

- Additional leak-checks were conducted if a leak exceeded 4 percent of the sampling rate, and efforts were made to improve the leak tightness of the train.

- The filter was maintained at the proper temperature.

- Ice was kept in the ice bath at all times.

- Proper readings of the dry gas meter, delta P and delta H, temperature, and pump vacuum were made during sampling at each traverse point. Copies of the field operator data sheets are shown in Appendix D.

- Isokinetic sampling was maintained within about 15 percent.

- Sample train and field blanks were collected for analysis and maintained at approximately 4°C.

After Testing Each Day

- The final meter reading was recorded.

- Completeness of the data sheet was checked.

- A final leak-check of the sampling train was done at the maximum vacuum observed during the test.

- Each leg of pitot tubes was leak-checked.

- Recovered train following prescribed procedures.

Quality Control Procedures for Method 23 (Modified Method 5, with Summa Canisters).

Prior to Start of All Testing

- The Method 23 trains were assembled in an environment free from uncontrolled dust.

- Each sampling train was visually inspected for proper assembly.
- All quartz filters to be used were muffled and cleaned XAD was prepared.
- Openings of all cleaned glassware and prepared sorbent traps were closed with ground glass caps or precleaned foil until train assembly.
- All filters were stored in a precleaned glass petri dish sealed with Teflon tape, and enclosed in aluminum foil.
- Pretest calculations were done to determine the proper sampling nozzle size.

<u>Prior to Testing Each Day</u>

- The number and location of the sampling points were checked before taking measurements.
- The sampling nozzle was visually inspected.
- Each leg of the pitot tube was leak-checked.
- The entire sampling train was leak-checked.
- The Summa canisters were checked for proper vacuum.

<u>During Testing Each Day</u>

- The roll and pitch axis of the pitot and the sampling nozzle were properly maintained.
- The train was leak-checked before and after the run, if the train was opened, and if a filter change took place.
- Additional leak-checks were conducted if the leak exceeded 4 percent of the sampling rate, and steps were taken to improve the leak tightness of the train.
- The filter and sorbent trap were maintained at the proper temperatures.
- Ice was kept in the ice bath at all times.

- Proper readings of the dry gas meter, delta P and delta H, temperature, and pump vacuum were made during sampling at each traverse point. Copies of the field data sheets are included in Appendix D.

- Isokinetic sampling was maintained within 15 percent.

- Sample train and field blanks were collected for PAH and dioxin/furan.

- Canister pressure was monitored by means of a pressure gauge throughout filling of the canister.

After Testing Each Day

- Final meter reading was recorded.

- Completeness of data sheet was checked.

- Final leak-check of sampling train at maximum vacuum during test was done.

- Final canister pressure was recorded, and the canister tightly closed.

- Each leg of pitot tubes was leak-checked.

- The probe rinses and remaining train were recovered following prescribed procedures.

- Nozzle and cap were reattached for next day and the train was stored in a dry, safe place.

Quality Control Procedures for Method 26A (Impinger Sampling Methods (Cyanide, Acid Gases, Aldehydes, Ammonia). Impinger-based sampling procedures were used for sampling aldehydes and inorganic compounds. These methods were conducted at single points in the flue gas stream, isokinetically except for the aldehyde sampling. The following general quality control procedures applicable to all these methods were followed:

Prior to Start of All Testing

- The trains were assembled in an environment free from uncontrolled dust.
- Each sampling train was visually inspected for proper assembly.

Prior to Testing Each Day

- Fresh impinger and rinse solutions were prepared.
- The sampling nozzle was visually inspected.
- The entire sampling train was leak-checked.

During Testing Each Day

- The filter was maintained at the proper temperature.
- Ice was maintained in the ice bath at all times.
- Proper readings of the dry gas meter, delta P and delta H, temperature, and pump vacuum during sampling at each traverse point were made. Sampling data sheets for these methods are included in Appendix D.
- Sample train and field blanks were collected for analysis.

After Testing Each Day

- Final readings were recorded.
- Completeness of data sheet was checked.
- Final leak-check of sampling train at maximum vacuum during test was done.
- Impinger solutions and rinses were recovered according to prescribed procedures.

Quality Control Procedures for VOST. Sampling for volatile organics was conducted using a Volatile Organic Sampling Train (VOST). The following are key quality control procedures followed in the field:

Prior to Start of All Testing

- VOST glassware was cleaned and assembled.
- The entire unit was assembled, visually inspected, leak tested, and its operation was checked.
- All VOST traps were cleaned, sealed, and labelled.

Prior to Testing Each Day

- VOST sorbent traps were kept sealed and stored in a refrigerator at 4°C.
- The VOST unit was assembled, minimizing the amount of time that the sorbent trap was open to air.
- A visual inspection was made and a leak test was made.

During Testing

- Flow rate was monitored.
- Operation of probe heater was monitored.
- Flow of ice water to condenser was maintained.
- Sampling time was watched closely, so the sampling interval was not overrun.

After Testing

- Final leak-check was performed.
- Sorbent traps were sealed immediately upon disassembly of the unit, and stored at 4°C until shipment for analysis.
- The VOST was prepared for its next use.

Quality Control Procedures for HEST Sampler. Volatile elements in flue gas were determined by means of a HEST sampler, that used carbon impregnated (CI) filters for collection of the metals. Field QC procedures for the HEST were as follows:

Prior to All Testing

- Lab ID numbers were recorded on the petri dishes in which the quartz and carbon impregnated (CI) filters are supplied.
- A clean table area for loading of the HEST filters was prepared.

Prior to Testing Each Day

- The positions of the one quartz and two CI filters in series were recorded as they were loaded, and recorded on the sample data sheet with the corresponding lab ID numbers.
- Both sides of each filter were examined to assure the proper side faced the air flow.
- Teflon-coated tweezers were used in loading the filters.
- The HEST filter assembly was visually inspected during and after assembly.
- Both ends of the assembly were sealed, and the entire assembly was then sealed in a clean plastic bag.

During Testing

- The system was leak tested after attachment of the HEST assembly to the probe.
- Condensate was not allowed to backwash into the HEST assembly.
- When inserting the HEST into the duct, care was taken to avoid scraping the head on the port.
- A proper seal was confirmed between the probe and port.
- Flow rate, sample time, and normal Method 5 sampling parameters were recorded.

After Testing

- When the assembly was removed from the duct, care was taken to avoid scraping the head on the port.
- Final leak test was performed.
- The HEST was kept vertical while the system was disassembled.
- The HEST was sealed, allowed to cool, and the entire assembly was then sealed into a plastic bag.
- Filters were kept flat with deposit side up while disassembling the HEST.
- Filters were placed flat with deposit side up in labelled petri dishes.
- Petri dishes were stored flat.
- Probe and filter chamber were rinsed with acetone and 0.1N HNO_3, and combined washes in a labelled sample jar.

Quality Control Procedures for Particle Size Distributions. At designated sampling locations, particle size distributions in flue gas were determined by cyclone or impactor sampling. The cyclones were incorporated in the Method 29 and Method 23 trains covered above, and used at Location 4. The following are QC procedures applicable to impactor sampling, which was conducted at Locations 5a and 5b.

Prior to Start of All Testing

- All impactor stage filters were preweighed.
- The impactors were assembled in an environment free from uncontrolled dust.
- Each unit was visually inspected for proper assembly.
- Labelled petri dishes were prepared for storage of impactor after sampling.
- Pretest calculations were performed to determine the proper sampling nozzle size.

Prior to Testing Each Day

- The sampling nozzle was visually inspected.

- The entire sampling train was leak-checked.

During Testing Each Day

- The impactor was allowed to warm to flue gas temperature before sampling.

- Isokinetic sampling was maintained within 10 percent.

After Testing Each Day

- Final leak-check of unit was done at maximum vacuum during test.

- Impactor was recovered following prescribed procedures.

- The impactor head was removed from the sampling probe, and sealed for transport to a clean disassembly area.

- Impactor filters were placed in pre-labelled dishes, and the impactor was cleaned for the next run.

Quality Control Procedures for Process Sample Collection. The process sampling quality control included the following procedures:

- The sampling equipment was cleaned and proper sample containers were used.

- Proper scheduling of sampling times was based on consultation with Niles staff.

- Immediate labelling of all samples was done at the time of collection.

- Observations were recorded on preformatted data sheets.

- Log-in and chain-of-custody procedures began as soon as samples were returned to the field laboratory.

METHOD 29 - MULTIPLE METALS

NOTE - INITIALLY, THIS GLASSWARE NEEDS TO BE SOAKED IN 10% HNO_3 FOR 4 HOURS IN A PLASTIC TUB, THEN RINSED 3X WITH DI H_2O BEFORE ASSEMBLING IMPINGER TRAINS

REAGENT PREPARATION

CYCLONES	FILTER	GLASSWARE RINSE SOLUTION 0.1N HNO_3	ACIDIFIED PEROXIDE IMPINGERS 2 AND 3 MAKE FRESH DAILY	10% H_2SO_4	ACIDIFIED 4% $KMnO_4$ IMPINGERS 5 AND 6 MAKE FRESH DAILY	SILICA GEL, INDICATING 3 - 8 MESH NONE
NONE	NONE	900ML DI H_2O 6.3ML CONC. HNO_3 DIL. TO 1000ML IN VOLUMETRIC WITH DI H_2O	500ML DI H_2O IN 1000ML VOLUMETRIC ADD 50ML CONC. ULTRAPURE HNO_3 ADD 333ML 30% H_2O_2 DILUTE TO VOLUME WITH DI H_2O	500ML DI H_2O IN 1000ML VOL. FLASK ADD 100ML CONC. H_2SO_4 DILUTE TO VOLUME WITH DI H_2O	900ML 10% H_2SO_4 IN 1000ML VOL. FLASK ADD 40GM $KMnO_4$, DISSOLVE DILUTE TO VOL. WITH 10% H_2SO_4	RINSE FOR #5 & #6 IMPINGE (8N HCL - 90ML DI H_2O IN 250ML VOL., ADD TO VOLUME WITH CONC HCL WITH COOLING)

IMPINGER TRAIN ASSEMBLY

CYCLONES (2)	FILTER	#1	#2	#3	#4	#5	#6	#7
		DI H_2O TO COVER INLET TUBE (WEIGH) (RECORD)	150ML ACIDIFIED PEROXIDE SOLUTION (WEIGH) (RECORD)	150ML ACIDIFIED PEROXIDE SOLUTION (WEIGH) (RECORD)	EMPTY (WEIGH) (RECORD)	100ML ACIDIFIED $KMnO_4$ SOLUTION (WEIGH) (RECORD)	100ML ACIDIFIED $KMnO_4$ SOLUTION (WEIGH) (RECORD)	200-300 GM SILICA GEL (WEIGH) (RECORD)

SAMPLE RECOVERY PROCEDURES

CYCLONES	FILTER	FRONT HALF OF FILTER HOUSING	PROBE LINER, NOZZLE AND SAMPLE LINE	FILTER SUPPORT AND BACK HALF OF HOUSING	IMPINGER #1	IMPINGER #2 & #3 (ACIDIFIED PEROXIDE)
EMPTY CONTENTS OF EACH INTO SEPARATE JARS AND SEAL WITH TEFLON TAPE	REMOVE FROM SUPPORT WITH TEFLON-COATED TWEEZERS AND PLACE IN PETRI DISH BRUSH LOOSE PARTICULATE ONTO FILTER WITH NON-METALLIC BRUSH AND SEAL PETRI DISH WITH TEFLON TAPE	BRUSH WITH NON-METALLIC BRUSH AND RINSE WITH ACETONE COMBINE ACETONE RINSES AND LABEL THEN RINSE 3X WITH 0.1N HNO_3 AND SAVE	RINSE WITH ACETONE BRUSH WITH NON-METALLIC BRUSH AND RINSE WITH ACETONE INSPECT LINER TO INSURE ALL PARTICULATE REMOVED. IF NOT, REPEAT BRUSH/RINSE COMBINE WITH ACETONE RINSE FROM FRONT HALF OF HOUSING THEN RINSE 3X WITH 0.1N HNO_3 AND SAVE WITH FRONT HALF HNO_3 RINSES	RINSE 3X WITH 0.1N HNO_3 AND SAVE	WEIGH AND RECORD SAVE AND LABEL RINSE 3X WITH 0.1N HNO_3 AND COMBINE WITH FILTER SUPPORT RINSE	WEIGH AND RECORD COMBINE AND SAVE RINSE 3X WITH 0.1N HNO_3 AND COMBINE WITH FILTER SUPPORT RINSE AND RINSE OF IMPINGER #1

IMPINGER #4	IMPINGER #5 & #6 (ACIDIFIED $KMnO_4$)	IMPINGER #7 (SILICA GEL)
WEIGH AND RECORD SAVE AND LABEL RINSE WITH 100ML 0.1N HNO_3 AND ADD TO SAMPLE BOTTLE	WEIGH AND RECORD COMBINE AND SAVE RINSE 3X WITH ACIDIFIED PERMANGANATE REAGENT THEN WITH DI H_2O ADD TO IMPINGER SAMPLE BOTTLE RINSE WITH 25ML 8N HCL AND SAVE SEPARATELY	WEIGH AND RECORD DISCARD

METHOD 23/ MODIFIED METHOD 5

PAH, DIOXINS/FURANS, SVOC

IMPINGER ASSEMBLY

CYCLONES (2)	FILTER	XAD/CONDENSER	SUMMA	IMPINGER #1	IMPINGERS #2 & #3	IMPINGER #4	IMPINGER #5
				DI H_2O TO COVER INLET TUBE WEIGH AND RECORD	100ML DI H_2O WEIGH AND RECORD	EMPTY	FILL 1/2 FULL WITH 3-8 MESH INDICATING SILICA GEL WEIGH AND RECORD

SAMPLE RECOVERY

CYCLONES (2)	FILTER	XAD/CONDENSER	SUMMA	IMPINGER #1	IMPINGERS #2 & #3	IMPINGER #4	IMPINGER #5
POUR INTO SEPARATE CONTAINERS AND LABEL	WEAR COTTON GLOVES REMOVE FROM HOLDER WITH TEFLON-COATED TWEEZERS AND PLACE IN PETRI DISH. BRUSH PARTICULATE ONTO FILTER AND SEAL DISH WITH TEFLON TAPE	CAP BOTH ENDS, WRAP IN ALUMINUM FOIL AND STORE AT 4C. CHESTER'S XAD TRAP WRAP ENDS WITH MUFFLED AL FOIL AND PLACE IN GLASS JAR. PACK WELL WITH MORE AL FOIL SEAL WITH TEFLON TAPE PROBE (SAMPLING PERSONNEL) RINSE WITH 50/50 MEOH/CH_2CL_2 SAVE AND TRANSPORT TO SAMPLE RECOVERY WITH XAD CARTRIDGE AND FILTER	CLOSE VALVE STORE @ AMBIENT	WEIGH AND RECORD SAVE AND LABEL RINSE WITH 50/50 MEOH/CH_2CL_2 AND ADD TO SAMPLE	WEIGH AND RECORD DISCARD RINSE WITH 50/50 MEOH/CH_2CL_2	WEIGH AND RECORD DISCARD RINSE WITH 50/50 MEOH/CH_2CL_2	WEIGH AND RECORD DISCARD INTO PLASTIC BAG FOR RECYCLING

METHOD 26A - ACID GASES, AMMONIA, AND CYANIDE

REAGENT PREPARATION

CO3/HCO3 SOLUTION	0.1N H2SO4	0.1M NAOH
SUPPLIED AS A CONCENTRATE DILUTE 1/200 WITH DI H2O	500ML DI H2O IN 1000ML VOL. FLASK ADD 5GM CONC. H2SO4 DILUTE TO VOLUME WITH DI H2O	500ML DI H2O IN 1000ML VOL. FLASK ADD 4GM NAOH DILUTE TO VOLUME WITH DI H2O

IMPINGER ASSEMBLY - ACID GASES

CYCLONE	FILTER	IMPINGER #1	IMPINGERS #2 & #3	IMPINGER #4
(ESP INLET ONLY)		DI H2O TO COVER INLET TUBE WEIGH AND RECORD	100ML CO3/HC03 IN EACH WEIGH AND RECORD	200-300GM 3-8 MESH INDICATING SILICA GEL WEIGH AND RECORD

SAMPLE RECOVERY - ACID GASES

CYCLONE	FILTER	IMPINGER #1	IMPINGERS #2 & #3	IMPINGER #4
EMPTY AND SAVE	REMOVE FROM HOLDER WITH TEFLON-COATED TWEEZERS AND PLACE IN PETRI DISH SEAL WITH TEFLON TAPE	WEIGH AND RECORD POUR INTO SAMPLE BOTTLE. RINSE WITH DI H2O AND ADD TO SAMPLE	WEIGH AND RECORD POUR INTO SAMPLE BOTTLE RINSE WITH C03/HCO3 SOLUTION ADD TO SAMPLE	WEIGH AND RECORD DISCARD IN PLASTIC BAG FOR RECYCLING

METHOD 26A - ACID GASES, AMMONIA, AND CYANIDE

IMPINGER ASSEMBLY - AMMONIA

CYCLONE	FILTER	IMPINGER #1	IMPINGERS #2 & #3	IMPINGER #4
(ESP INLET ONLY)		DI H_2O TO COVER INLET TUBE WEIGH AND RECORD	100ML 0.1N H_2SO_4 IN EACH WEIGH AND RECORD	200-300GM 3-8 MESH INDICATING SILICA GEL WEIGH AND RECORD

SAMPLE RECOVERY - AMMONIA

CYCLONE	FILTER	IMPINGER #1	IMPINGERS #2 & #3	IMPINGER #4
EMPTY AND SAVE	LEAVE IN PLACE FOR NEXT RUN	WEIGH AND RECORD POUR INTO SAMPLE BOTTLE RINSE WITH DI H_2O AND ADD TO SAMPLE	WEIGH AND RECORD POUR INTO SAMPLE BOTTLE RINSE WITH 0.1N H_2SO_4 SOLUTION ADD TO SAMPLE CHECK $pH < 2$	WEIGH AND RECORD DISCARD IN PLASTIC BAG FOR RECYCLING

METHOD 26A - ACID GASES, AMMONIA, AND CYANIDE

IMPINGER ASSEMBLY - CYANIDE

CYCLONE	FILTER	IMPINGER #1	IMPINGERS #2 & #3	IMPINGER #4
(ESP INLET ONLY)	SAME FROM PRECEDING RUN	DI H2O TO COVER INLET TUBE WEIGH AND RECORD	100ML 0.1M NAOH IN EACH WEIGH AND RECORD	200-300GM 3-8 MESH INDICATING SILICA GEL WEIGH AND RECORD

SAMPLE RECOVERY - CYANIDE

CYCLONE	FILTER	IMPINGER #1	IMPINGERS #2 & #3	IMPINGER #4
EMPTY AND SAVE	REMOVE FROM HOLDER WITH TEFLON-COATED TWEEZERS AND PLACE IN PETRI DISH BRUSH PARTICULATE ONTO FILTER AND SEAL WITH TEFLON TAPE	WEIGH AND RECORD POUR INTO SAMPLE BOTTLE RINSE WITH DI H2O AND ADD TO SAMPLE	WEIGH AND RECORD POUR INTO SAMPLE BOTTLE RINSE WITH 0.1M NAOH SOLUTION ADD TO SAMPLE CHECK pH > 10	WEIGH AND RECORD DISCARD IN PLASTIC BAG FOR RECYCLING

MODIFIED METHOD 0011 - FORMALDEHYDE

REAGENT PREPARATION

ACIDIFIED DNPH (DINITRO PHENYL HYDRAZINE) REAGENT
EMPTY PREWEIGHED ALIQUOT OF PURIFIED DNPH
INTO 1000ML BOTTLE OF ACETONITILE. ADD 0.200 ML CONC. H_2SO_4
STORE UNUSED PORTION AT 4C UNTIL NEEDED

IMPINGER ASSEMBLY

(NOTE - THIS METHOD USES MINI IMPINGERS)

CYCLONES	FILTER	IMPINGER #1	IMPINGER #2 & #3	IMPINGER #4
NONE		DI H2O TO COVER INLET TUBE WEIGH AND RECORD	20ML ACIDIFIED DNPH REAGENT WEIGH AND RECORD	SILICA GEL, 3-8 MESH, INDICATING WEIGH AND RECORD

SAMPLE RECOVERY

FILTER	IMPINGER #1	IMPINGER #2 & #3	IMPINGER #4
REMOVE AND DISCARD	WEIGH AND RECORD POUR INTO SAMPLE BOTTLE RINSE WITH DI H2O AND ADD TO SAMPLE	WEIGH AND RECORD POUR INTO ONE SAMPLE BOTTLE RINSE WITH ACN (ACETONITRILE) AND ADD TO SAMPLE	WEIGH AND RECORD DISCARD INTO PLASTIC BAG FOR RECYCLING

APPENDIX D

FIELD SAMPLING DATA SHEETS

APPENDIX D

FIELD SAMPLING DATA SHEETS

In this Appendix, copies are provided of the original field sampling data sheets and calculation spreadsheets from the field study at Niles Boiler No. 2. These sheets show the data recorded by the Battelle and Chester staff in conducting the flue gas measurements. The data sheets are organized in the following order:

D-1: Modified Method 5
D-2: Multi-Metals
D-3: Anions Train
D-4: Ammonia Train
D-5: Cyanide Train
D-6: Aldehyde Train
D-7: VOST Train
D-8: HEST Samples
D-9: Cascade Impactors
D-10: PSDS Sampler
D-11: High-Volume Sampler (Soot Blowing)
D-12: Flue Gas Sampling Calculation Spreadsheets.

Within Sections D-1 to D-11, the data sheets are presented in order by site and date. For example, in Section D-1, data sheets from sites 4, 5a, and 5b on July 26 are provided, followed by those from sites 4, 5a, and 5b on July 28, etc.

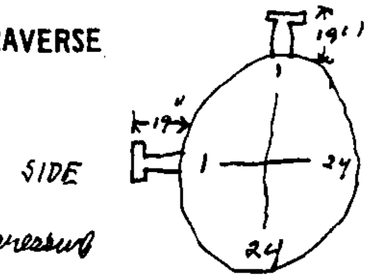
Section D-12 shows the calculation results for each of the isokinetic, traversing sampling runs at Niles Boiler No. 2. These results include primary flue gas characteristics, as well as derived values such as isokinetic rate, flue gas volume flow rates, etc. The results are presented for Locations 4 and 5a.

D-1: Modified Method 5

PRELIMINARY VELOCITY TRAVERSE

PLANT niles, Ohio
DATE 7/26/93
LOCATION ESP inlet 4
STACK I.D. 11 ft. 8"
BAROMETRIC PRESSURE, in. Hg
STACK GAUGE PRESSURE, in. H_2O 0.2
OPERATORS Leonard, Kupp

stack pressure



SCHEMATIC OF TRAVERSE POINT LAYOUT

SIDE

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	0	197
2	0.01	280
3	0.37	305
4	0.61	312
5	0.79	313
6	0.86	313
7	0.90	311
8	0.94	310
9	0.92	310
10	0.92	308
11	0.92	308
12	0.85	306
13	0.83	305
14	0.83	304
15	0.83	303
16	0.82	302
17	0.81	301
18	0.79	301
19	0.78	300
20	0.73	299
21	0.70	299
22	0.63	298
23	0.57	296
24	—	—
AVERAGE		

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~0.82 300

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	0	208
2	0.38	267
3	0.55	297
4	0.64	299
5	0.72	300
6	0.78	300
7	0.88	300
8	0.90	300
9	0.91	300
10	0.94	301
11	0.91	302
12	0.91	303
13	0.78	307
14	0.77	308
15	0.78	309
16	0.79	310
17	0.80	310
18	0.81	311
19	0.80	311
20	0.77	311
21	0.71	312
22	0.65	312
23	0.63	312
24	0.60	312
AVERAGE		

NOMOGRAPH DATA

PLANT Niles, Ohio, Ohio Edison

DATE 7/26/93

SAMPLING LOCATION ESP inlet

N-4-MM5-726

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.65
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m_{avg.}}$	100
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	7
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1.0
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	310
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	0.85
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	1.00
C FACTOR		0.90
CALCULATED NOZZLE DIAMETER, in.		0.235
ACTUAL NOZZLE DIAMETER, in.		0.247
REFERENCE Δp, in. H_2O		0.750

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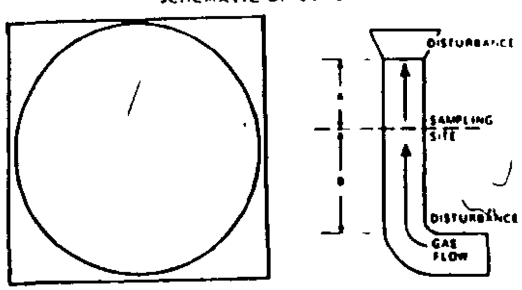
Checked by:__________

#1

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

PLANT Niles Ohio, Ohio
DATE 7/26/93
LOCATION ESP inlet
OPERATOR Leonard, Hupp
STACK NO.
RUN NO. N-4-MM5-726
SAMPLE BOX NO. 5A
METER BOX NO. X-40513

AMBIENT TEMPERATURE 93
BAROMETRIC PRESSURE
ASSUMED MOISTURE, % 7
PROBE LENGTH, in. 13 ft. glass
NOZZLE DIAMETER, in. 0.247
STACK DIAMETER, in. 140"
PROBE HEATER SETTING 250°F
HEATER BOX SETTING 250°F

METER $\Delta H_@$ 1.60
C FACTOR 0.95
PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER (TOP)	SAMPLING TIME (θ), min.	Probe Temp °F (~~STATIC PRESSURE (in. H2O)~~)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	O_2 % (~~VELOCITY~~)
1	0 / 14:17	250	223	0.19	0.50	0.50	181.000			260	79	3.6	4.0
2	15 / 14:32	249	303	0.63	1.65	1.65	187.1	102	99	258	79	7.2	3.9
3	30 / 14:48	251	304	0.79	2.00	2.00	197.4	105	100	XAD-2 41 260	73	9.8	4.0
4	45 / 15:03	249	305	0.88	2.30	2.30	208.0	105	101	257	78	13.0	3.6
5	60 / 15:17	248	306	0.91	2.35	2.35	220.2	104	101	259	75	15.5	4.1
6	75 / 15:32	249	306	0.91	2.35	2.35	233.1	103	102	259	80	17.5	4.0
7	90 / 15:47	248	309	0.88	2.30	2.30	245.5	100	100	260	85	20.0	4.4
8	105 / 16:02	249	315	0.83	1.90	2.20	256.9	98	98	XAD-2 42 258	86	21.5	3.9
9	120 / 16:17	252	315	0.81	1.50	2.50	267.9	89	98	257	88	21.5	4.0
10	135 / 16:32	253	318	0.83	1.90	2.20	278.3	99	99	259	88	22.0	4.3
11	150 / 16:47	251	321	0.66	1.40	1.70	288.2	97	97	XAD-2 42 258	78	22.0	4.0
12	165 / 17:02	256	321	0.64	1.10	1.60	298.0	97	96	262	76	22.0	4.1
	180 / 17:17	off					306.359						
SIDE 1	180 / 18:17	on 240	305	0.15	0.40	0.40	306.591	94	94	235	88	4.0	3.9
2	195 / 18:32	245	322	0.47	1.20	1.20	312.3	96	94	XAD-2 43 256	50	2.0	4.0
TOTAL													
AVERAGE													

leak check at 1/2 min 0.022 at 22" Hg
Heated line 248 & 252°F

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

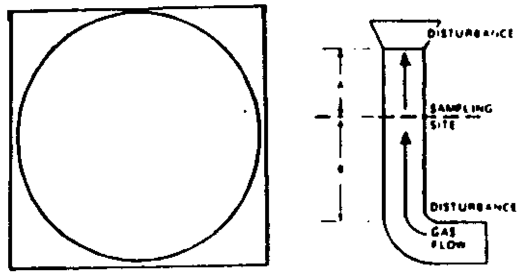
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS: Change filter at 1/2 way point

#2

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

PLANT Niles, Ohio, Ohio edison
DATE 7/26/93
LOCATION ESP inlet
OPERATOR Lemal, Hupp
STACK NO.
RUN NO. N-4-MMF-726
SAMPLE BOX NO. 5A
METER BOX NO. X-40513

AMBIENT TEMPERATURE 95
BAROMETRIC PRESSURE
ASSUMED MOISTURE, % 7
PROBE LENGTH, in. 13ft. glass
NOZZLE DIAMETER, in. 0.247
STACK DIAMETER, in. 140'
PROBE HEATER SETTING 250°F
HEATER BOX SETTING 250°F

METER $\Delta H_@$ 1.65
C FACTOR 0.95
PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	probe Temp °F (~~STATIC PRESSURE (in. H_2O)~~)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	O_2 % (~~VELOCITY~~)
3	210/19:47	247	322	0.81	2.20	2.20	321.4	97	94	257	60	11.0	3.9
4	225/19:02	251	323	0.92	2.40	2.40	333.8	101	97	259	62	16.0	4.0
5	240/19:17	248	320	0.96	2.50	2.60	346.1	97	96	MAF 39 268	64	20.0	4.0
6	255/19:32	248	323	0.90	2.30	2.30	359.3	96	95	259	68	21.0	4.0
7	270/19:47	246	317	0.90	2.00	2.30	371.4	93	93	256	68	21.0	4.0
8	285/20:02	248	315	0.84	1.70	2.20	382.7	91	92	258	68	21.5	4.1
9	300/20:17	252	312	0.83	1.50	2.20	393.3	90	91	257	67	21.5	3.6
10	315/20:32	252	310	0.74	1.30	1.95	403.3	89	89	258	66	21.7	3.5
11	330/20:47	253	308	0.67	1.20	1.80	412.7	88	88	259	67	22.0	3.5
12	345/21:02	255	306	0.60	1.10	1.60	421.4	89	88	259	68	22.0	3.5
	360/20:17	off					430.597						
TOTAL													
AVERAGE													

leak check after run 0.012 at 28" Hg
heated lines 253°F + 258°F

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS
0.55" H_2O
STATIC PRESSURE

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT Stack - Hot Side
PROJECT NO. 93C0328-01
CONTROL BOX OPERATOR JPS
BAROMETRIC PRESSURE 29.00

TEST DATE 7-26-93 (Mon.)
TEST NO. N-5a-MM5-726
NOZZLE (SIZE,#) 0.192
STATIC PRESSURE -1.0" H_2O
PORT DIRECTION A

ORIFICE CORRECTION 1.572
METER CORRECTION 1.0151
CALIBRATION DATE 7-2-93
PITOT CORRECTION 0.84
CONTROL BOX NO. 3

HOT BOX NO. 4
COLD BOX NO. 4+3A
PROBE NO. 5-3
FILTER NO.
STACK DIA. [redacted] 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1 [redacted]	1200	007.653	1.1	0.91	0.91	100	96	5.0	291	~250°F	<68°F	~250°F	30 min/point
			1.1	0.91	0.91	108	98	4.5	291				Readings every
			1.1	0.91	0.91	113	100	6.5	289				5 min
			1.1	0.91	0.91	115	102	6.0	289				
			1.1	0.91	0.91	118	104	6.0	291				
			1.1	0.91	0.91	119	106	6.0	289				
19.3 [redacted]	1230		1.1	0.91	0.91	122	108	6.0	289				
			1.1	0.92	0.92	123	110	6.0	289				
			1.1	0.92	0.92	124	110	6.0	289				
			1.1	0.92	0.92	124	112	6.0	289				
			1.0	0.84	0.84	125	112	6.0	290				
			1.0	.84	.84	125	113	6.0	290				
5[redacted].8	1300		1.0	.84	.84	127	114	6.0	289				
			0.80	.67	.67	126	114	5.0	290				Estimates:
			.75	.63	.63	127	115	5.0	290				MW=29.3
			.75	.63	.63	127	115	5.0	290				%H2O=9
			.75	.63	.63	126	116	5.0	290				
	1330	50.600	.75	.63	.63	126	116	5.0	291				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	0.010
After	6.5	<0.015 cfm

PITOT LEAK CHECK 15 sec

	Positive	Negative
Before	OK	OK
After	OK/15 sec	OK/15 sec

	1	2
CO2	15.5	15.5
O2	7.5	7.5
CO	0	0
N2	77.0	77.0

Tyrite Check 16:04 O_2 = 20.5

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	XAD-2 + Condensate	1560.9	1241.5	319.4
2.	Empty	496.2	486.0	10.2
3.	100 mL D.I. H_2O	539.8	544.5	-4.7
4.	100 mL D.I. H_2O	520.4	518.9	1.5
5.	Silica Gel	712.2	670.4	41.8

368.2 g total

Actual Moisture 9.2%

TIME = 90 min
VOLUME = 42.947 dcf
$(\Delta H)_{AG} = 0.82$

$(T_{meter})_{AG}$ = 115°F

velocity = 67.6 ft/sec

KEYSTONE

AQE 2/92

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT Stack - Hot Side
PROJECT NO. 93C0 28-01
CONTROL BOX OPERATOR JTS
BAROMETRIC PRESSURE 29.00

TEST DATE 7-26-93 (Mon.)
TEST NO. N-5a-MM5-726
NOZZLE (SIZE,") 0.192
STATIC PRESSURE -1.0" H2O
PORT DIRECTION Port "B"

ORIFICE CORRECTION 1.572
METER CORRECTION 1.0151
CALIBRATION DATE 7-2-93
PITOT CORRECTION 0.84
CONTROL BOX NO. 3

HOT BOX NO. 4
COLD BOX NO. 4+34
PROBE NO. 5-3
FILTER NO.
STACK DIA. [redacted] 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1 [redacted]	13:36	50.690	1.0	.84	.84	115	115	6.0	290	~250°F	<68°F	~250°F	30 min/point
			1.0	.84	.84	120	116	6.0	292				Readings every
			1.0	.84	.84	125	116	6.0	291				5 min
			1.0	.84	.84	129	116	6.0	292				
			1.0	.84	.84	129	117	6.0	292				
			1.0	.84	.84	130	117	6.0	291				
19.3 [redacted]			1.0	.84	.84	129	117	6.5	290				
			1.0	.84	.84	129	117	7.0	292				
			1.0	.84	.84	130	118	7.0	293				
			1.0	.84	.84	130	118	7.0	291				
			1.0	.84	.84	131	118	7.0	292				
			1.0	.84	.84	130	118	7.0	293				
5 [redacted].8			.75	.63	.63	131	118	6.0	290				
			.75	.63	.63	130	118	6.0	290				
			.75	.63	.63	130	118	6.0	291				Estimates:
			.75	.63	.63	130	118	6.0	291				MW= 29.3
			.75	.63	.63	130	118	6.0	290				%H2O= 9
	15:06	096.466	.75	.63	.63	131	118	6.0	290				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	6.5	<0.015 cfm
After	7.0	<0.015 cfm

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	15.5	
O2	7.5	
CO	0	
N2	77.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

TIME = 90 min
volume = 45.776 dcf
(ΔP)avg = 0.90
(ΔH)avg = 0.77

(Tmeter)avg = 123°F
(Tstack)avg = 291°F

velocity = 64.1 ft/sec
Iso. = 95.0%

KEYSTONE

AQE 2/92

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE	TEST DATE 7-26-93 (Mon.)	ORIFICE CORRECTION 1.572	HOT BOX NO. 4
TEST UNIT Stack - Hot Side	TEST NO. N-5Q-MM5-726	METER CORRECTION 1.0161	COLD BOX NO. 4+3A
PROJECT NO. 93C028-01	NOZZLE (SIZE,#) 0.192	CALIBRATION DATE 7-2-93	PROBE NO. 5-3
CONTROL BOX OPERATOR JPS	STATIC PRESSURE -1.0" H_2O	PITOT CORRECTION 0.84	FILTER NO.
BAROMETRIC PRESSURE 29.00	PORT DIRECTION Port C	CONTROL BOX NO. 3	STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	15:18	96.550	1.0	.84	.84	125	119	7.0	290	~250°F	<68°F	~250°F	30 min/point
			1.0	.84	.84	126	119	7.0	290				Readings every
			1.1	.92	.92	130	119	7.0	291				5 min
			1.1	.92	.92	130	118	7.0	296				
			1.2	1.01	1.01	133	118	7.5	297				
			1.2	1.01	1.01	132	119	7.5	297				
19.3			1.2	.99	.99	132	120	7.0	297				
			1.2	.99	.99	133	120	7.0	297				
			1.2	.99	.99	132	120	7.0	296				
			1.2	.99	.99	133	120	7.0	298				
			1.2	.99	.99	132	120	7.0	291				
			1.2	.99	.99	132	120	7.0	298				
5.8			1.2	.99	.99	130	121	7.0	298				
			1.2	.99	.99	130	121	7.0	296				
			1.2	.99	.99	134	120	7.0	298				Estimates:
			1.2	.99	.99	132	120	7.0	296				MW=29.3
			1.2	.99	.99	132	120	7.0	296				%H2O-9
	16:48	151.075	1.2	.99	.99	132	120	7.0	297				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	7.0	<0.015 cfm
After	8.0	<0.015 cfm

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	15.5	
O2	7.5	
CO	0	
N2	77.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Page #3 values

TIME = 90 min

VOLUME = 54.525 dcf

$(\Delta P)_{AVG}$ = 1.2

... = .97

$(T_{meter})_{AVG}$ = 125°F

velocity = 74.3 ft/sec

... = 29.9%

ISO. = 98.0%

AQE 2/92

KEYSTONE

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT Stack - Hot Side
PROJECT NO. 93C022D-01
CONTROL BOX OPERATOR JB
BAROMETRIC PRESSURE 29.00

TEST DATE 7-26-93 (Mon.)
TEST NO. N-5a-MM5-726
NOZZLE (SIZE,D) 0.192
STATIC PRESSURE -1.0" H2O
PORT DIRECTION PORT D

ORIFICE CORRECTION 1.572
METER CORRECTION 1.0151
CALIBRATION DATE 7-2-93
PITOT CORRECTION 0.84
CONTROL BOX NO. 3

HOT BOX NO. 4
COLD BOX NO. 4734
PROBE NO. 5-3
FILTER NO.
STACK DIA. [redacted] 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
37.1 [redacted]	1705	151.250	1.1	.91	.91	120	118	7.5	299	~250°F	<68°F	~250°F	30 min port
			1.1	.91	.91	130	120	7.0	299				Readings every
			1.1	.91	.91	132	120	7.0	300				5 min
			1.1	.91	.91	132	120	7.0	300				
			1.2	.99	.99	153	120	7.0	300				
			1.2	.99	.99	133	120	7.0	300				
19.3 [redacted]			1.1	.91	.91	132	120	7.0	301				
			1.1	.91	.91	132	120	7.0	301				
			1.2	.99	.99	132	120	7.0	301				
			1.1	.91	.91	134	120	7.0	301				
			1.1	.91	.91	133	120	7.0	300				
			1.2	.99	.99	132	120	7.0	300				
5 6.8			1.0	.83	.83	133	120	6.0	301				
			1.1	.91	.91	133	120	6.0	301				
			1.2	.99	.99	133	121	6.5	301				Estimates:
			1.2	.99	.99	133	121	7.0	300				MW=29.3
			1.1	.91	.91	135	123	7.0	301				%H2O=9
	18.35	199.940	1.1	.91	.91	134	121	7.0	302				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After	8.0	<0.05

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	15.5	
O2	7.5	
CO	0	
N2	77.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Page #4 values
TIME = 90 min
VOLUME = 48.690 dcf
(ΔP)AVG = 1.1
(ΔH) = 0.92

(Tmeter)AVG = 126°F
(Tstack) = 300°F
velocity = 71.3 ft/sec
ISO = 91.5%

KEYSTONE

AQE 2/92

STACK SAMPLING DATA SHEET

CLIENT Battelle DOE
TEST UNIT 665-DB 513
PROJECT NO.
CONTROL BOX OPERATOR D. Brown
BAROMETRIC PRESSURE 29.0

TEST DATE 7-26-93
TEST NO. ~~H-63-MMS-726~~
NOZZLE (SIZE,#) N-58-MMS-726
STATIC PRESSURE —
PORT DIRECTION —

ORIFICE CORRECTION 1.821
METER CORRECTION .91049
CALIBRATION DATE 7-16-93
PITOT CORRECTION —
CONTROL BOX NO. 2 Portland

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. —
FILTER NO. —
STACK DIA.

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
	1235	179.852	—	1.0	1.0	105	102	4	~~75~~	—	66	—	
	1245	~~192.975~~		1.0	1.0	113	103	4			64		
	1255	192.975		1.0	1.0	122	106	4			63		
	1305	198.7		1.0	1.0	126	109	4			63		
	1315	205.9		1.0	1.0	130	113	4			61		
	1325	212.4		1.0	1.0	130	115	4			59		
	1335	217.9		1.0	1.0	132	117	4			58		
	1345	226.1		1.2	1.2	134	118	4			58		
	1355	232.5		1.2	1.2	134	119	4			57		
	1405	238.9		1.2	1.2	134	120	4			57		
	1415	246.0		1.2	1.2	135	121	4			57		
	1425	252.5		1.4	1.4	136	121	4			56		
	1435	260.1		1.5	1.5	137	121	5			56		
	1445	268.2		1.5	1.5	137	122	5			57		
	1455	275.1		1.5	1.5	137	122	5			57		Estimates:
	1505	283.2		1.7	1.7	138	122	5			57		MW=
	1515	290.9		1.7	1.7	139	123	5			57		%H2O=
	1525			1.7	1.7	139	123	5			56		

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	15	0.015
After	15	0.008

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

KEYSTONE

AQE 2/92

STACK SAMPLING DATA SHEET

CLIENT Battelle DOE
TEST UNIT Dilute 5B
PROJECT NO. 93C028
CONTROL BOX OPERATOR D. Brown
BAROMETRIC PRESSURE 29.0

TEST DATE 7-26-93
TEST NO. ~~N-5B-MMS-726~~
NOZZLE (SIZE,#) N-5B-MMS-726
STATIC PRESSURE
PORT DIRECTION

ORIFICE CORRECTION 1.821
METER CORRECTION 0.9649
CALIBRATION DATE 7-16-93
PITOT CORRECTION —
CONTROL BOX NO. 2 Portacal

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. —
FILTER NO. —
STACK DIA. —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
	1535	306.9	—	1.7	1.7	139	123	5	—	—	55	—	
	1545	315.1		1.7	1.7	138	123	5			54		
	1555	322.6		1.7	1.7	139	123	5			53		
	1605	330.6		1.9	1.9	139	123	5			53		
	1615	339.1		1.9	1.9	139	123	5			52		
	1625	347.2		1.9	1.9	139	123	5			53		
	1635			1.9	1.9	140	124	5			52		
	1645	364.3		1.9	1.9	140	124	5			53		
	1655	372.8		1.9	1.9	140	124	5			54		
	1705	380.7		1.9	1.9	140	125	5			52		
	1715	388.9		1.9	1.9	140	126	5			53		
	1725	387.0		1.9	1.9	140	125	5			54		
	1735	405.8		1.9	1.9	140	125	5			54		
	1745	414.1		1.9	1.9	140	125	5			53		
	1755	.		1.9	1.9	141	125	5			53		Estimates:
	1805	430.9		1.9	1.9	141	125	5			53		MW=
	1815	439.6		1.9	1.9	142	126	5			53		%H2O=
	1825	448.2		1.9	1.9	141	124	5			53		

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 2/92

KEYSTONE

STACK SAMPLING DATA SHEET

CLIENT Battelle DOE
TEST UNIT ~~LB DR~~ Dilute 5B
PROJECT NO. 93C028
CONTROL BOX OPERATOR D. Brown
BAROMETRIC PRESSURE 29.0

TEST DATE 7-26-93
TEST NO. ~~N-6B-MM5-726~~
NOZZLE (SIZE,#) — N-5B-MM5-726
STATIC PRESSURE —
PORT DIRECTION —

ORIFICE CORRECTION 1.821
METER CORRECTION 0.9649
CALIBRATION DATE 7-14-93
PITOT CORRECTION —
CONTROL BOX NO. Box 2 Port

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. —
FILTER NO. —
STACK DIA. —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
	1835	456.7	—	1.9	1.9	142	123	5	—	—	55	—	
	1845	4164.552		1.9	1.9	142	123	5			56		

Estimates:
MW=
%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

KEYSTONE

AQE 2/92

NOMOGRAPH DATA

PLANT Niles, Ohio; Ohio Edison

DATE 7/28/93

SAMPLING LOCATION ESP inlet

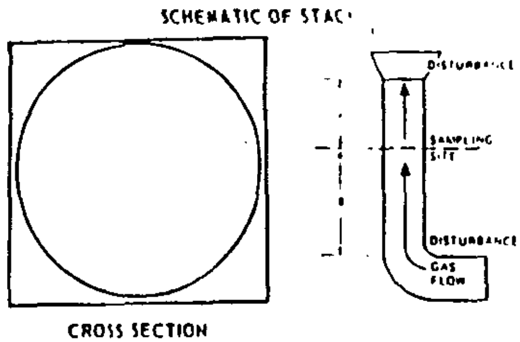
N-4-MM5-728

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.65
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m_{avg.}}$	100
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	7
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.84
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1.0
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	310
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	0.90
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	1.20
C FACTOR	0.95	
CALCULATED NOZZLE DIAMETER, in.	0.230	
ACTUAL NOZZLE DIAMETER, in.	0.182	
REFERENCE Δp, in. H_2O	2.15	

EPA (Dur) 234
4/72

Checked by:__________

PARTICULATE FIELD DATA



PLANT Niles Ohio Ohio Edison
DATE 7/28/93
LOCATION ESP inlet
OPERATOR Leonard, Hupp
STACK NO
RUN NO. N-4-MM5-728
SAMPLE BOX NO. 5
METER BOX NO. X-40513

AMBIENT TEMPERATURE 84
BAROMETRIC PRESSURE 28.84
ASSUMED MOISTURE, % 7
PROBE LENGTH, in. 13 ft. glass
NOZZLE DIAMETER, in. 0.182
STACK DIAMETER, in. 140"
PROBE HEATER SETTING 250°F
HEATER BOX SETTING 250°F

METER $\Delta H_@$ 1.65
C FACTOR 0.95
PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
	TOTAL	

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min	Probe Temp °F ~~STATIC PRESSURE (in. H_2O)~~	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	O_2 % ~~VELOCITY fpm~~
1	0/10:20	262		0.32		0.26	0.26	611.154	86	86	263	67	7.0	4.2
2	15/10:35	264	300	0.71		0.58	0.58	615.7	89	88	[illegible] ON 264	60	5.1	4.4
3	30/10:50	263	302	0.90		0.72	0.72	622.2	92	89	4" OFF 264	XAD-2 44 59	6.8	4.4
4	45/11:05	264	302	1.10		0.90	0.90	629.7	95	93	[illegible] ON 265	62	8.2	4.0
5	60/11:20	263	302	1.10		0.90	0.90	637.9	97	94	6" 266	XAD-2 43 62	9.5	4.4
6	75/11:35	262	302	1.10		0.90	0.90	646.4	98	96	[illegible] 266	XAD2 43 65	10.2	4.2
7	90/11:50	262	303	0.97		0.78	0.78	654.5	97	96	[illegible] 261	69	10.2	4.0
8	105/12:05	263	310	0.94		0.76	0.76	662.4	97	96	15" 265	XAD-2 43 73	11.0	4.3
9	120/12:20	264	312	0.98		0.78	0.78	670.0	98	97	15" [illegible] OFF 264	68	12.0	4.4
10	135/12:35	265	314	0.96		0.78	0.78	678.4	99	97	264	68	13.0	4.3
11	150/12:50	264	316	0.85		0.70	0.70	686.0	99	98	262	69	13.5	4.6
12	165/13:05	267	318	0.75		0.60	0.60	693.0	99	98	264	70	13.5	4.6
	180/13:20	off						700.051						
J105 1	180/13:21	on 265		0.13		0.10	0.10	700.031	98	98	261	-92		
	181/13:32	off change filter		leak	check	0.017 at 14" Hg								
TOTAL														

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

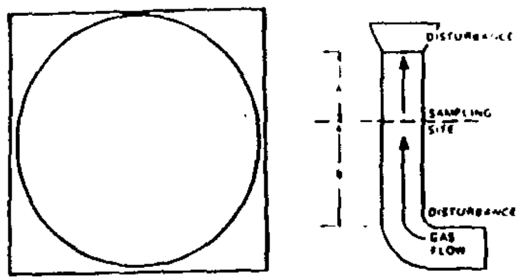
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS

#2

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

PLANT Niles, Ohio, Ormet ... AMBIENT TEMPERATURE 95 METER $\Delta H_@$ 1.65

DATE 7/28/93. BAROMETRIC PRESSURE 28.78 C FACTOR 0.95

LOCATION ESP inlet ASSUMED MOISTURE, % 7 PROCESS WEIGHT RATE

OPERATOR Lemark, Kaye PROBE LENGTH, in. 130.

STACK NO. NOZZLE DIAMETER, in. 0.182

RUN NO. N-4-MM5-728 STACK DIAMETER, in. 140"

SAMPLE BOX NO. 5 PROBE HEATER SETTING 250°F

METER BOX NO. X-40513 HEATER BOX SETTING 250°F

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min	probe temp, °F ~~STATIC PRESSURE (in. H_2O)~~	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	O_2 % ~~VELOCITY~~
1	181/14:18	on 269	310	0.20	0.16	0.16	700.816	101	100	~~232~~	83	4.0	4.3
2	195/14:32	263	312	0.42	0.34	0.34	704.4	100	99	274	~~XAD-2 54~~ 80	5.0	3.9
3	210/14:47	264	319	0.82	0.66	0.66	710.4	100	100	272	76	7.0	4.4
4	225/15:02	263	319	0.90	0.72	0.72	718.0	100	100	273	63	8.0	4.1
5	240/15:17	264	316	0.97	0.80	0.80	725.9	100	100	274	XAD-2 48 65	9.0	4.5
6	255/15:32	262	314	1.10	0.90	0.90		99	100	273	66	11.0	4.1
7	270/15:47	263	313	0.91	0.74	0.74	741.9	99	99	274	69	11.0	4.5
8	285/16:02	263	308	0.91	0.74	0.74	749.7	99	99	274	70	11.0	4.5
8	298/16:15	off shovel rim					756.405						
8	298/16:29	on					756.405						
9	300/16:31	260	304	0.90	0.72	0.72	757.3	94	94	271	XAD-2 52 65	11.0	4.2
10	315/16:46	262	301	0.88	0.70	0.70	764.7	93	93	272	XAD-2 61	11.6	4.3
11	330/17:01	263	300	0.73	0.60	0.60	771.8	93	93	273	50 ~~XAD-2~~ 62	12.0	4.4
12	345/17:16	261	298	0.65	0.53	0.53	778.7	93	93	273	50 66	12.0	4.2
	360/17:31	off					785.227						
TOTAL													
AVERAGE													

leak test after 0.022 at 14" Hg

heated line 257°F + 253°F

COMMENTS

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

I	1577	HOT BOX NO. 4
	60151	COLD BOX NO. 4
	07-02-93	PROBE NO. 5-3
	0.84	FILTER NO. UNWGIGNGO
	THREE	STACK DIA. 132"

STACK SAMPLING DATA SHEET

CLIENT	BATTELLE / AOR	TEST DATE	07-28-93 (Wed.)	ORIFICE CORRECTION	1.572	HOT BOX NO.	4
TEST UNIT	STACK HOT SIDE	TEST NO.	N-5a-MM5-728	METER CORRECTION	1.0157	COLD BOX NO.	4
PROJECT NO.	93 020-01	NOZZLE (SIZE,#)	0.192	CALIBRATION DATE	07-02-93	PROBE NO.	5-3
CONTROL BOX OPERATOR	RPC	STATIC PRESSURE	-1.2" H_2O	PITOT CORRECTION	0.84	FILTER NO.	UNWEIGHED
BAROMETRIC PRESSURE	28.96	PORT DIRECTION	PORT B	CONTROL BOX NO.	THREE	STACK DIA.	13

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	1058	416555	1.2	.98	.98	122	115	5.5	290	~250°	<68°	~250°	30 min/pt
			1.2	.98	.98	127	114	5.5	291				Some readings
			1.2	.98	.98	128	115	6.0	291				Isokinetic
			1.0	.82	.82	128	115	6.0	291				
			1.0	.82	.82	128	116	6.0	291				
			1.2	.98	.98	129	116	6.0	291				
19.3			1.2	.98	.98	129	117	6.0	291				
			1.1	.90	.90	130	117	5.5	292				
			1.1	.90	.90	130	117	5.5	292				
			1.1	.90	.90	131	117	5.5	292				
			1.1	.90	.90	130	118	5.5	291				
			1.1	.90	.90	131	117	5.5	292				
5.8			.80	.67	.67	130	117	4.5	291				
			.90	.75	.75	130	117	5.0	291				
			.90	.75	.75	129	118	5.0	291				Estimates:
			.90	.75	.75	129	118	5.0	291				MW= 29.1
			.90	.75	.75	130	118	5.0	290				%H2O= 9.0
	12:28	461.435	.80	.67	.67	130	118	5.0	291				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	15.0	
O2	7.0	
CO	0	
N2	78.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Run #2 Values

TIME = 90 min

VOLUME = 44.880 dcf

$(\Delta P)_{AVG} = 1.05$

$(\Delta H)_{AVG} = 0.85$

$(T_{meter})_{AVG} = 123°F$ $(T_{stack})_{AVG} = 291°F$

velocity = 69.1 ft/sec

Iso. = 86.5%

KEYSTONE

AQE 2/92

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT Stack - Hot Side
PROJECT NO. 93C028-01
CONTROL BOX OPERATOR RPC
BAROMETRIC PRESSURE 28.96

TEST DATE 07-28-93 (Wed.)
TEST NO. N-59-MM5-728
NOZZLE (SIZE,#) 0.192
STATIC PRESSURE -1.2" H_2O
PORT DIRECTION Port C

ORIFICE CORRECTION 1.572
METER CORRECTION 1.0151
CALIBRATION DATE 07-02-93
PITOT CORRECTION 0.84
CONTROL BOX NO. Three

HOT BOX NO. 4
COLD BOX NO. 4
PROBE NO. 5-3
FILTER NO. UNWG13HG0
STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	12:33	461.435	1.20	1.00	1.00	123	117	6.5	293	~250°F	<68°F Ice Down	~250°F	30min/pt
			1.2	1.00	1.00	129	118	7.0	291				5 min Readings
			1.2	1.00	1.00	131	118	7.0	293				Isokinetic
			1.3	1.08	1.08	131	118	7.0	294				
			1.3	1.08	1.08	132	118	7.0	294				
			1.3	1.08	1.08	132	119	7.0	294				
19.3			1.1	.92	.92	132	119	6.5	294				
			1.1	.92	.92	132	119	6.5	294				
			1.1	.92	.92	133	119	6.5	295				
			1.1	.92	.92	133	118	6.5	295				
			1.1	.92	.92	133	120	6.5	295				
			1.1	.92	.92	133	120	6.5	296				
5.8			1.0	.83	.83	133	121	6.0	295				
			.90	.75	.75	133	120	6.0	296				
			.90	.75	.75	133	121	6.0	295				Estimates:
			.90	.75	.75	133	120	6.0	295				MW= 29.1
			1.0	.83	.83	133	121	6.5	295				%H2O= 29.0
	14:03	510.920	1.0	.83	.83	133	121	6.5	295				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	15.0	
O2	7.0	
CO	0	
N2	78.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Page #3 values

TIME = 90min
VOLUME = 49.485 dcf
$(\Delta P)_{AVG} = 1.10$
$(\Delta H)_{AVG} = 0.92$

$(T_{meter})_{AVG} = 126°F$ $(T_{stack})_{AVG} = 294°F$

velocity = 70.9 ft/sec
ISO. = 92.8%

AQE 2/92

KEYSTONE

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT Stack Hot Slag
PROJECT NO. 93C028-01
CONTROL BOX OPERATOR RPC
BAROMETRIC PRESSURE 28.96

TEST DATE 07-28-93 (Wed.)
TEST NO. N-5a-MM5-728
NOZZLE (SIZE,#) 0.192
STATIC PRESSURE -1.2" H_2O
PORT DIRECTION Port D

ORIFICE CORRECTION 1.572
METER CORRECTION 1.0151
CALIBRATION DATE 07-02-93
PITOT CORRECTION 0.84
CONTROL BOX NO. Three

HOT BOX NO. 4
COLD BOX NO. 4
PROBE NO. 5-3
FILTER NO. unweighed
STACK DIA. 132

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	14:09	510.920	1.3	1.08	1.08	123	118	7.0	295	~260°F	<68°F [illegible]	~250°	30 min/pt
			1.2	1.00	1.00	132	121	7.0	295				readings
			1.2	1.00	1.00	132	121	7.0	295				every 5 min
			1.2	1.00	1.00	134	121	7.0	295				
			1.2	1.00	1.00	134	121	7.0	295				
			1.2	1.00	1.00	134	121	7.0	295				
19.0	14:39		1.2	1.00	1.00	134	121	7.0	295				
			1.2	1.0	1.0	135	121	7.0	295				
			1.2	1.0	1.0	135	121	7.0	295				
			1.2	1.0	1.0	135	121	7.0	295				
			1.2	1.0	1.0	136	122	7.0	295				
			1.2	1.0	1.0	136	122	7.0	295				
5.8	15:09		1.0	.83	.83	135	122	6.5	295				
			1.0	.83	.83	135	122	6.5	294				
			1.0	.83	.83	135	122	6.5	295				Estimates:
			1.0	.83	.83	135	122	6.5	294				MW= 29.1
			.90	.75	.75	135	121	6.0	294				%H2O= 9.0
	15:39	560.860	.90	.75	.75	134	122	6.0	295				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	15.0	
O2	7.0	
CO	0	
N2	78.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

TIME = 90 min
VOLUME = 49.940 dcf
AQE 2/92 (ΔP)/ΔH = 1.10
[illegible] = 0.9[illegible]

(Tank) ΔH = 128 [illegible]

velocity = 70.9 ft/sec
ISO = 93.5%

KEYSTONE

STACK SAMPLING DATA SHEET

CLIENT Battelle PO E
TEST UNIT 5B
PROJECT NO. 93-C028
CONTROL BOX OPERATOR D. Brown
BAROMETRIC PRESSURE 28.96

TEST DATE 7-28-93
TEST NO. N-5B-MM5-728
NOZZLE (SIZE,#) —
STATIC PRESSURE —
PORT DIRECTION —

ORIFICE CORRECTION 1.821
METER CORRECTION 0.9649
CALIBRATION DATE 7-16-93
PITOT CORRECTION —
CONTROL BOX NO. Box 2 Portland

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. —
FILTER NO. —
STACK DIA. —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
—	0900	786.140	—	2.0	2.0	104	100	6	—	—	65	—	
	0910	794.3		2.0	2.0	119	103	6			60		
	0920	803.2		2.0	2.1	125	100	6			55		
	0930	811.8		2.1	2.1	129	109	6			54		
	0940	820.1		2.1	2.1	130	112	6			54		
	0950	828.7		2.1	2.1	132	114	6			53		
	~~1000~~												
	0955	833.071		2.1	2.1	134	117				53		Shut down
													Sheared Pi
	~~1015~~												~~START~~
	1020	833.071		2.1	2.1	109	106				52		START
	1030	841.3		2.1	2.1	~~106~~ 121	107				52		
	1040	850.3		2.1	2.1	129	111				51		
	1050	858.5		2.1	2.1	131	113				51		
	1100	868.2		2.1	2.1	135	117				52		Estimates:
	1110	876.4		2.1	2.1	136	118				52		MW=
	1120	884.6		2.1	2.1	136	118				52		%H2O=
	1130	892.8		2.1	2.1	138	119				52		

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	10"	0.012
After	12"	0.012

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 2/92

KEYSTONE

STACK SAMPLING DATA SHEET

CLIENT	Battelle DOE	TEST DATE	7-28-93	ORIFICE CORRECTION	1.821	HOT BOX NO.	—
TEST UNIT	5B	TEST NO.	N-5B-MMS-728	METER CORRECTION	0.9649	COLD BOX NO.	—
PROJECT NO.	93028	NOZZLE (SIZE,#)	—	CALIBRATION DATE	7-16-93	PROBE NO.	—
CONTROL BOX OPERATOR	D. Brown	STATIC PRESSURE	—	PITOT CORRECTION	—	FILTER NO.	—
BAROMETRIC PRESSURE	28.96	PORT DIRECTION	—	CONTROL BOX NO.	Box 2 Portman	STACK DIA.	—

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
	1140	901.6		2.1	2.1	137	120	6			53		
	1150	909.9		2.1	2.1	138	121	6			53		
	1200	918.7		2.1	2.1	138	120	6			52		
1205	~~1210~~	923.532						6			52		Power Out
	~~1220~~												
1220	~~1230~~	923.532		2.1	2.1	121	119	6			51		START
	1230	932.4		2.1	2.1			6			52		
	1240	940.8		2.1	2.1	136	120	6			51		
	1250	948.6		2.1	2.1	137	120	6			53		
	1300	958.2		2.1	2.1	139	121	6			52		
	1310	966.5		2.1	2.1	139	121	6			53		
	1320	975.2		2.1	2.1	141	122	6			53		
	1330	984.1		2.1	2.1	142	124	6			53		
	1340	992.6		2.1	2.1	142	125	6			53		
	1350	001.3		2.1	2.1	143	125	6			52		Estimates:
	1400	010.7		2.1	2.1	142	125	6			52		MW=
	1410	017.5		2.1	2.1	142	126	6			53		%H2O=
	1420	027.5		2.1	2.1	143	125	6			53		

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 2/92

KEYSTONE

STACK SAMPLING DATA SHEET

CLIENT Battelle DOE	TEST DATE 7-28-93	ORIFICE CORRECTION 1.821	HOT BOX NO. —
TEST UNIT 5B	TEST NO. N-5B-MMS-728	METER CORRECTION 0.9419	COLD BOX NO. —
PROJECT NO. 93-1028	NOZZLE (SIZE,#) —	CALIBRATION DATE 7-16-93	PROBE NO. —
CONTROL BOX OPERATOR D. Burn[illegible]	STATIC PRESSURE —	PITOT CORRECTION —	FILTER NO. —
BAROMETRIC PRESSURE 28.76	PORT DIRECTION —	CONTROL BOX NO. Box 2 P[illegible]	STACK DIA. —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
—	1430	035.9	—	2.1	2.1	143	126	6	—	—	52	—	
	1440	043.2		2.1	2.1	143	124	6			53		
	1450	052.9		2.1	2.1	143	126	6			53		
	1500	061.7		2.1	2.1	143	120	6			53		
	1510	070.4		2.1	2.1	144	127	6			54		
	1520	079.3		2.1	2.1	144	127	6			53		
	1530	087.8		2.1	2.1	144	127	6			53		
	1540	096.812											
													Estimates:
													MW=
													%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

KEYSTONE

AQE 2/92

NOMOGRAPH DATA

PLANT Niles, Ohio . Ohio Edison

DATE 7/30/93

SAMPLING LOCATION ESP inlet

N-4-MM5-730

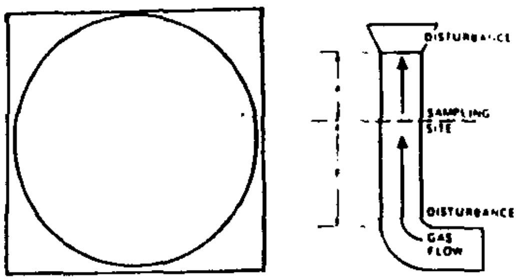
CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.65
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m_{avg.}}$	90
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	7
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.77
STATIC PRESSURE IN STACK, in. Hg (P_m ± 0.073 x STACK GAUGE PRESSURE in in. H_2O)	P_s	
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1.0
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	310
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	0.85
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	
C FACTOR		0.92
CALCULATED NOZZLE DIAMETER, in.		0.238
ACTUAL NOZZLE DIAMETER, in.		0.182
REFERENCE Δp, in. H_2O		2.40

EPA (Dur) 234
4/72

Checked by:

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

PLANT Niles, Ohio, Ohio Edison
DATE 7/30/93
LOCATION ESP inlet
OPERATOR Leonard, Hupp
STACK NO. ______
RUN NO. N-4-MM5-730
SAMPLE BOX NO. 5
METER BOX NO. 4-40573

AMBIENT TEMPERATURE 62
BAROMETRIC PRESSURE 28.77
ASSUMED MOISTURE, % 7
PROBE LENGTH, in. 13 ft.
NOZZLE DIAMETER, in. 0.180
STACK DIAMETER, in. 140
PROBE HEATER SETTING 250°F
HEATER BOX SETTING 250°F

METER ΔH@ 1.65
C FACTOR 0.98
PROCESS WEIGHT RATE ______

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
	TOTAL	

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	probe temp °F ~~STATIC PRESSURE (in. H2O)~~	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	O_2 % ~~VELOCITY~~
1	0/9:15	250		0.28	0.22	0.22	952.175	63	62	268	49	2.2	4.0
2	15/9:30	251	290	0.63	0.46	0.46	955.5	65	64	[illegible] 270	XAD-2 44 49	5.2	4.1
3	30/9:45	250	290	0.81	0.62	0.62	961.1	66	64	21" 268	46	6.0	4.0
4	45/10:00	252	291	1.10	0.88	0.88	967.3	66	65	19" 270	47	8.0	4.0
5	60/10:15	250	292	1.10	0.88	0.88	975.3	66	65	[illegible] 269	XAD-2 40 47	8.5	4.1
6	75/10:30	250	291	1.20	0.94	0.94	983.2	65	64	16" 269	47	10.0	
7	90/10:45	251	292	1.10	0.88	0.88	991.4	65	64	7" 270	48	10.5	4.1
8	105/11:00	252	293	0.96	0.74	0.74	998.8	66	64	[illegible] 270	XAD-2 40 49	10.5	4.1
9	120/11:15	242	298	0.92	0.72	0.72	1006.8	67	66	[illegible] 267	50	10.5	4.2
10	135/11:30	248	303	0.85	0.66	0.66	1013.3	66	66	[illegible] 272	52	10.5	
11	150/11:45	245	304	0.77	0.60	0.60	1020.1	66	65	[illegible] 269	52	11.0	4.2
12	165/12:00	254	305	0.66	0.57	0.57	1026.9	66	64	266	51	10.2	4.2
	180/12:15 [illegible]						1033.090						—
1	180/12:30	254	267	0.12	0.10	0.10	1033.090	64	64	266	60	3.5	4.0
2	195/12:45	250	307	0.58	0.44	0.44	1034.8	64	64	266	XAD-2 41 60	9.0	4.0
TOTAL													
AVERAGE													

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

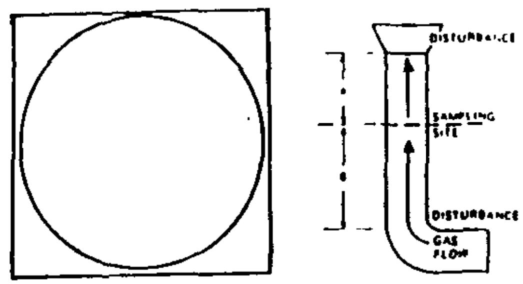
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

H N

PARTICULATE FIELD DATA

SCHEMATIC OF STAC



CROSS SECTION

PLANT Niles, Ohio, Ohio Edison
DATE 7/30/93
LOCATION ESP inlet
OPERATOR Leonard, Kupp
STACK NO.
RUN NO. N-4-MM5-730
SAMPLE BOX NO. 5
METER BOX NO. X-40513

AMBIENT TEMPERATURE 63
BAROMETRIC PRESSURE 28.80
ASSUMED MOISTURE, % 7
PROBE LENGTH, in. 13 ft.
NOZZLE DIAMETER, in. 0.182
STACK DIAMETER, in. 140"
PROBE HEATER SETTING 250°F
HEATER BOX SETTING 250°F

METER $\Delta H_@$ 1.63
C FACTOR 0.95
PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
	TOTAL	

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	probe temp °F ~~STATIC PRESSURE (in. H_2O)~~	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	O_2 % ~~VELOCITY fps~~
3	210/13:00	251	308	0.89	0.68	0.68	1039.8	65	65	266	53	12.5	4.2
4	225/13:15	250	308	1.00	0.78	0.78	1047.6	67	65	XAD-2 40 266	52	13.0	4.1
5	240/13:30	246	305	0.96	0.74	0.74	1055.1	68	66	268	55	13.5	4.1
6	255/13:45	250	304	1.00	0.78	0.78	1062.4	68	67	269	55	14.5	4.5
7	270/14:00	250	301	0.92	0.72	0.72	1069.7	67	66	267	55	15.0	4.4
8	285/14:15	250	297	0.92	0.72	0.72	1077.1	67	66	XAD-2 79 269	56	15.0	4.2
9	300/14:30	252	294	1.00	0.78	0.78		66	65	268	67	17.0	4.0
10	315/14:45	251	297	0.85	0.66	0.66	1091.4	65	65	269	58	17.0	3.6
11	330/15:00	252	289	0.75	0.60	0.60	1098.3	65	64	269	59	17.0	3.8
12	345/15:15	253	287	0.75	0.60	0.60	1104.7	65	64	269	60	17.0	3.4
	360/15:30	off					1111.974						
TOTAL													
AVERAGE													

leak check after, 0.015 at 18" Hg

COMMENTS

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

STACK SAMPLING DATA SHEET

CLIENT	BATTELLE / DOE	TEST DATE	07-30-93 (Fri.)	ORIFICE CORRECTION	1.572
TEST UNIT	STACK - HOT SIDE	TEST NO.	N-5a-MM5-730	METER CORRECTION	1.0151
PROJECT NO.	93C628-01	NOZZLE (SIZE, in)	.192	CALIBRATION DATE	07-02-93
CONTROL BOX OPERATOR	RPC	STATIC PRESSURE	-1.2" H_2O	PITOT CORRECTION	0.84
BAROMETRIC PRESSURE	28.88	PORT DIRECTION	PORT A	CONTROL BOX NO.	THREE

HOT BOX NO. 4
COLD BOX NO. 4
PROBE NO. 5-3
FILTER NO. UNWEIGHED
STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	0900	735.150	1.2	.98	.98	87	92	4.0	289	~250°F	<68°F Ice!	~250°F	30 min / PT
			1.2	.98	.98	97	87	4.0	288				5 min Readings
			1.2	.98	.98	101	89	4.0	286				
			1.2	.98	.98	101	89	4.0	285				
	0925	748.245	1.2	.98	.98	106	89	5.5	283				STOPPED TEST TO
	0932	749.350	1.2	.98	.98	100	89	4.5	285				REPLACE BROKEN
19.3			1.0	.83	.83	107	94	4.0	285				GLASS ELBOW
			1.0	.83	.83	108	94	4.0	283				RESTART AT 932
			1.0	.83	.83	108	95	4.0	282				
			1.0	.83	.83	110	97	4.0	283				
			1.1	.90	.90	111	97	4.0	282				
			1.1	.90	.91	111	97	4.0	283				
5.8			.80	.66	.66	111	99	3.5	284				
			.80	.66	.66	111	99	3.5	283				
			.80	.66	.66	112	98	3.5	290				Estimates:
			.80	.66	.66	110	98	3.5	290				MW= 29.6
			.80	.66	.66	110	98	3.5	286				%H2O= 9.0
	1037	780.875	.80	.66	.66	110	99	3.5	285				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	<0.02 cfm
After	6.0	<0.02 cfm

PITOT LEAK CHECK

	Positive	Negative
Before	OK/15 sec	OK/15 sec
After	OK/15 sec	OK/15 sec

	1	2
CO2	14.5	14.5
O2	6.0	6.0
CO	0	0
N2	79.5	79.5

FYRITE CHECK 20.5% O_2 AT 12:30

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	XAD + CONDENSATE	1518.7	1222.9	295.8
2.	DRY	433.1	425.4	8.7
3.	100 ml H_2O	557.2	558.4	-1.2
4.	100 ml H_2O	525.1	522.9	2.2
5.	SILICA GEL	722.5	687.2	35.3

340.8 g total

Actual Moisture =

TIME = 90 min
volume = 45.725 dcf
$(\Delta P)_{avg} = 1.00$
$(\Delta H)_{avg} = 0.83$

$(T_{meter})_{avg} = 100°F$
$(T_{stack})_{avg} = 285°F$

velocity = 67.3 ft/sec
ISO. = 93.4%

AQE 2/92

KEYSTONE

STACK SAMPLING DATA SHEET

CLIENT BATTELLE / DOE
TEST UNIT STACK HOT SIDE
PROJECT NO. 93C028-01
CONTROL BOX OPERATOR RPC
BAROMETRIC PRESSURE 28.88

TEST DATE 07-30-93 (Fri.)
TEST NO. N-59-MM5-73
NOZZLE (SIZE,#) 0.192
STATIC PRESSURE -1.2" H_2O
PORT DIRECTION Port B

ORIFICE CORRECTION 1.572
METER CORRECTION 1.0161
CALIBRATION DATE 07-02-93
PITOT CORRECTION 0.84
CONTROL BOX NO. THREE

HOT BOX NO. 4
COLD BOX NO. 4
PROBE NO. 5-3
FILTER NO. [illegible]
STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	10:42	780.875	1.2	.98	.98	104	99	5.5	281	~250°F	<68°F [illegible]	~250°F	30min / PT
			1.2	.98	.98	110	98	5.5	294				5min / Reading
			1.2	.98	.98	112	98	5.5	286				
			1.2	.98	.98	112	99	5.5	284				
			1.2	.98	.98	113	99	5.5	286				
			1.2	.98	.98	112	99	5.5	289				
A3			1.0	.82	.82	113	99	5.0	284				
			1.0	.82	.82	112	99	5.0	286				
			1.0	.82	.82	113	99	5.0	285				
			1.0	.82	.82	113	99	5.0	283				
			1.0	.82	.82	112	99	5.0	285				
			.95	.78	.78	112	99	5.0	285				
5.8			.80	.66	.66	111	99	4.5	279				
			.80	.66	.66	111	98	4.5	283				
			.80	.66	.66	111	98	4.5	283				Estimates:
			.80	.66	.66	112	98	4.5	282				MW= 29.5
			.80	.66	.66	112	98	4.5	285				%H2O= 9.0
	12:12	827.830	.80	.66	.66	111	98	4.5	283				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	14.5	
O2	6.0	
CO	0	
N2	79.5	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

2nd #2 value

TIME = 90 min
VOLUME = 46.955 dcf
$(\Delta P)_{AVG}$ = 1.00
$(\Delta H)_{AVG}$ = 0.82
$(T_{meter})_{AVG}$ = 106°F
$(T_{stack})_{AVG}$ = 285°F

velocity = 67.3 ft/sec
Iso. = 95.1%

KEYSTONE

AQE 2/92

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT Stack – Hot Side
PROJECT NO. 93C028P-01
CONTROL BOX OPERATOR RPC
BAROMETRIC PRESSURE 28.88

TEST DATE 07-30-93 (Fri)
TEST NO. N-59-MM5-730
NOZZLE (SIZE,#) 0.172
STATIC PRESSURE -1.2" H_2O
PORT DIRECTION Port C

ORIFICE CORRECTION 1.572
METER CORRECTION 1.0151
CALIBRATION DATE 07-02-93
PITOT CORRECTION 0.84
CONTROL BOX NO. Three

HOT BOX NO. 4
COLD BOX NO. 4
PROBE NO. 5-3
FILTER NO. LWWS 3H60
STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	12:17	827.830	1.2	.98	.98	103	98	6.0	289	~250°F	[illegible]	250°F	30 min/pt
			1.2	.98	.98	110	98	6.0	284				5 min leakage
			1.2	.98	.98	111	98	6.0	285				
			1.2	.98	.98	112	98	6.0	290				
			1.2	.98	.98	112	98	6.0	286				
			1.2	.98	.98	112	98	6.0	289				
19.3			1.0	.82	.82	112	99	5.5	290				
			1.0	.82	.82	111	99	5.5	287				
			1.1	.90	.90	112	99	6.0	286				
			1.1	.90	.90	112	99	6.0	287				
			1.0	.82	.82	111	99	5.5	290				
			1.0	.82	.82	112	99	5.5	281				
5.8			.95	.78	.78	112	99	5.5	285				
			.95	.78	.78	112	99	5.5	280				
			.95	.78	.78	111	99	5.8	289				Estimates:
			.95	.78	.78	111	99	5.5	291				MW= 29.5
			.95	.78	.78	111	99	5.5	291				%H2O= 9.0
	13:47	876.175	.95	.78	.78	111	99	5.5	285				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	14.5	
O2	6.0	
CO	0	
N2	79.5	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Rep #3 calcs
TIME = 90 min
VOLUME = 48.345 dcf
$(\Delta P)_{AVG} = 1.05$
$(\Delta H)_{AVG} = 0.87$
$(T_{meter})_{AVG} = 105°F$
$(T_{stack})_{AVG} = 287°F$
velocity = 69.0 ft/sec
ISO = 95.7%

AQE 2/92

KEYSTONE

STACK SAMPLING DATA SHEET

CLIENT Battelle Moe
TEST UNIT Stack - Hot Side
PROJECT NO. 93C022 01
CONTROL BOX OPERATOR RPC
BAROMETRIC PRESSURE 28.88

TEST DATE 07-30-93 (FRI.)
TEST NO. N-59-MM5-730
NOZZLE (SIZE,#) 0.192
STATIC PRESSURE -1.2" H_2O
PORT DIRECTION Port

ORIFICE CORRECTION 1.577
METER CORRECTION 1.0151
CALIBRATION DATE 07-02-93
PITOT CORRECTION 0.84
CONTROL BOX NO. Three

HOT BOX NO. 4
COLD BOX NO. 4
PROBE NO. 5-3
FILTER NO. Unassigned
STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	13:52	876.175	1.2	.98	.98	105	95	6.0	290	~250°	<68° Ice Bath	~250°	30 min/pt
	13:52		1.2	.98	.98	109	99	6.0	285				Readings
			1.2	.98	.98	109	99	6.0	284				Every 5 min
			1.2	.98	.98	111	99	6.0	280				
			1.2	.98	.98	111	99	6.0	280				
			1.2	.98	.98	111	99	6.0	280				Halted test at 14:27 for
19.3	14:27	895.275	1.1	.90	.90	111	98	5.5	289				Port Assem.
	14:29	895.275	1.1	.90	.90	111	99	5.5	286				Restarted at
			1.1	.90	.90	110	98	5.5	287				
			1.1	.90	.90	112	99	5.5	287				
			1.1	.90	.90	112	99	5.5	286				
			1.1	.90	.90	111	99	5.5	286				
5.8			.95	.78	.78	111	99	5.0	291				
			.95	.78	.78	111	98	5.0	290				
			.95	.78	.78	111	98	5.0	295				Estimates:
			.95	.78	.78	111	98	5.0	295				MW= 29.5
	15:24		.95	.78	.78	111	98	5.0	295				%H2O= 9.0
	15:24	925.184	.95	.78	.78	111	99	5.0	296				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	14.5	
O2	6.0	
CO	0	
N2	79.5	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Page #4 Values
TIME = 90 min
VOLUME = 49.009 dcf
AQE 2/92 $(\Delta P)_{AVG}$ = 1.10
$(\Delta H)_{AVG}$ = 0.89

$(T_{meter})_{AVG}$ = 105°F
$(T_{stack})_{AVG}$ = 287°F

Velocity = 70.6 ft/sec
ISO. = 94.9%

KEYSTONE

KEYSTONE
ENVIRONMENTAL RESOURCES, INC.

STACK SAMPLING DATA SHEET

1/3

PLANT: Niles, Ohio
LOCATION:
ACTIVITY NO: 93-C028
CONTROL BOX OPERATOR D. Brown
PROBE HANDLER —
CLEAN UP —

DATE: 7-30-93
TEST NO.: N-5B-MM5-730
NOZZLE: —
STATIC PRESSURE Ps: —
PORT DIRECTION: —
BAROMETRIC PRESSURE 28.93

ΔH@: 1.821
METER CORRECTION: 0.9649
PITOT CORRECTION: —
CONTROL BOX NO.: Box 2 Portland
NOMOGRAPH SET POINT: —
LENGTHS OF UMBILICAL — x 25' — x 50'

HOT BOX NO.: —
COLD BOX NO.: —
PROBE NO.: —
FILTER NO.: —
STACK DIA.: —

Point	Time	Meter Reading (dry) CF	Velocity HD in. H_2O	Orifice ΔH in. H_2O Req.	Orifice ΔH in. H_2O Act.	Meter Temp. T_m °F In	Meter Temp. T_m °F Out	Vacuum V_m in. Hg	Stack Temp. T_s °F	Probe Temp. T_p °F	Imp. Temp. T_I °C/°F	Hot Box Temp. T_H °F	Comments
—	0905	411.734	—	2.4	2.4	90	89	11.5	—	—	61	—	
	0915	420.6		2.4	2.4	100	89	11.0			56		
	0925	429.4		2.4	2.4	107	91	11.0			52		
	0935	438.6		2.4	2.4	111	95	11.0			49		
	0945	447.3		2.4	2.4	113	97	11.0			48		
	0955	456.1		2.4	2.4	115	99	11.0			48		
	1005	465.1		2.4	2.4	116	101	11.0			47		
	1015	473.8		2.4	2.4	117	102	10.5			47		
	1025	482.4		2.4	2.4	117	102	10.5			47		
	1035	491.6		2.4	2.4	117	103	10.5			47		
1045	~~1045~~	500.8		2.4	2.4	118	103	10.5			46		
1055	~~1055~~	50		2.4	2.4	118	103	10.5			46		
1105	~~1105~~	518.2		2.4	2.4	118	103	10.5			47		
1115	1105	527.2		2.4	2.4	118	103	10.5			48		
	1125	535.9		2.4	2.4	118	103	10.5			48		
	1135	544.0		2.4	2.4	117	103	10.5			46		

LEAK CHECK CFM

	in Hg	Rate
Before	15	0.003
After	16	0.002

ORSAT

	1	2	3
CO_2			
O_2			
CO			
N			

Impinger No.	Final	Initial	Difference
1			
2			
3			
4			
5			

KEYSTONE
ENVIRONMENTAL RESOURCES, INC.

STACK SAMPLING DATA SHEET

2/3

PLANT: Niles, Ohio
LOCATION: —
ACTIVITY NO: 93028
CONTROL BOX OPERATOR D. Brown
PROBE HANDLER —
CLEAN UP —

DATE: 7-30-93
TEST NO.: N-5B-MM5-730
NOZZLE: —
STATIC PRESSURE Ps: —
PORT DIRECTION: —
BAROMETRIC PRESSURE 28.93

ΔH@: 1.821
METER CORRECTION: 0.9649
PITOT CORRECTION: —
CONTROL BOX NO.: Box 2 Portland
NOMOGRAPH SET POINT: —
LENGTHS OF UMBILICAL — x 25' — x 50'

HOT BOX NO.: —
COLD BOX NO.: —
PROBE NO.: —
FILTER NO.: —
STACK DIA.: —

Point	Time	Meter Reading (dry) CF	Velocity HD In. H_2O	Orifice ΔH In. H_2O Reg.	Orifice ΔH In. H_2O Act.	Meter Temp., T_m °F In	Meter Temp., T_m °F Out	Vacuum V_m In. Hg	Stack Temp. T_s °F	Probe Temp. T_p °F	Imp. Temp. T_I °C/°F	Hot Box Temp. T_H °F	Comments
—	1145	553.5	—	2.4	2.4	117	102	10.5	—	—	43	—	
	1155	562.6		2.4	2.4	116	102	10.5			43		
	1205	571.5		2.4	2.4	118	103	10.5			42		
	1215	580.2		2.4	2.4	117	103	10.5			42		
	1225	589.2		2.4	2.4	117	103	10.5			41		
	1235	597.9		2.4	2.4	117	103	10.5			40		
	1245	606.7		2.4	2.4	117	103	10.5			40		
	1255	615.4		2.4	2.4	117	103	10.5			41		
	1305	624.7		2.4	2.4	117	103	10.5			41		
	1315	633.4		2.4	2.4	117	103	10.5			39		
	1325	642.6		2.4	2.4	117	103	10.5			38		
	1335	651.1		2.4	2.4	117	103	10.5			39		
	1345	660.2		2.4	2.4	117	103	10.5			38		
	1355	669.1		2.4	2.4	117	103	10.5			37		

LEAK CHECK

	In Hg	Rate
Before		
After		

ORSAT

	1	2	3
CO_2			
O_2			
CO			
N			

Impinger No.	Final	Initial	Difference
1			
2			
3			
4			
5			

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

STACK SAMPLING DATA SHEET

3/3

PLANT: Niles Ohio DATE: 7-30-93 ΔH@: 1.821 HOT BOX NO.: —

LOCATION: — TEST NO.: N-5B-MM5-730 METER CORRECTION: 0.9049 COLD BOX NO.: —

ACTIVITY NO: 93C028 NOZZLE: — PITOT CORRECTION: — PROBE NO.: —

CONTROL BOX OPERATOR D. Brown STATIC PRESSURE Ps: — CONTROL BOX NO.: Box 2 Portland FILTER NO.: —

PROBE HANDLER — PORT DIRECTION: — NOMOGRAPH SET POINT: — STACK DIA.: —

CLEAN UP — BAROMETRIC PRESSURE 28.93 LENGTHS OF UMBILICAL — x 25' — x 50'

Point	Time	Meter Reading (dry) CF	Velocity HD In. H_2O	Orifice ΔH In. H_2O Req.	Orifice ΔH In. H_2O Act.	Meter Temp. T_m °F In	Meter Temp. T_m °F Out	Vacuum V_m In. Hg	Stack Temp. T_s °F	Probe Temp. T_p °F	Imp. Temp. T_I °C/°F	Hot Box Temp. T_H °F	Comments
—	1405	677.9	—	[illegible]	2.4	116	102	10.5	—	—	42	—	
	1415	687.2		2.4	2.4	116	102	10.5			42		
	1424	694.215											Shutdown
	1427	694.215		2.4	2.4	112	101	10.5			49		On
	1437	703.3		2.4	2.4	114	100	10.5			42		
	1447	712.5		2.4	2.4	115	101	10.5			42		
	1457	721.5		2.4	2.4	116	102	10.5			42		
1503	[illegible]	727.79		2.4	2.4	116	102	10.5			42		END

LEAK CHECK

	In Hg	Rate
Before		
After		

ORSAT

	1	2	3
CO_2			
O_2			
CO			
N			

Impinger No.	Final	Initial	Difference
1			
2			
3			
4			
5			

D-2: Multi-Metals (Method 29)

NOMOGRAPH DATA

PLANT Niles, Ohio, Ohio Edison

DATE 7/27/93

SAMPLING LOCATION ESP inlet,

N-4-MUM-727

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.65
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m_{avg.}}$	110
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	7
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.84
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	0.65" H_2O
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1.0
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	315
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	0.80
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	0.96
C FACTOR	0.95	
CALCULATED NOZZLE DIAMETER, in.	0.240	
ACTUAL NOZZLE DIAMETER, in.	0.182	
REFERENCE Δp, in. H_2O	2.2	

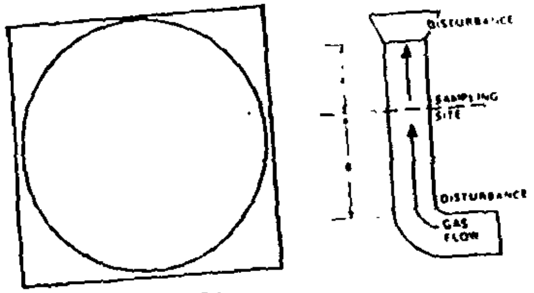
EPA (Dur) 234
4/72

Checked by:__________

#1

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

PLANT Miles Ohio
DATE 7/27/93
LOCATION ESP inlet
OPERATOR Leonard, Hunt
STACK NO.
RUN NO. N-4-MUM-727
SAMPLE BOX NO. 1
METER BOX NO. X-40583

AMBIENT TEMPERATURE
BAROMETRIC PRESSURE
ASSUMED MOISTURE, %
PROBE LENGTH, in.
NOZZLE DIAMETER, in.
STACK DIAMETER, in.
PROBE HEATER SETTING
HEATER BOX SETTING

METER $\Delta H_@$
C FACTOR
PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
	TOTAL	

TOP TRAVERSE POINT NUMBER	~~SAMPLING TIME~~ (min.)	probe temp °F ~~STATIC PRESSURE (in. H_2O)~~	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	O_2 % ~~VELOCITY~~
1	0/11:20	235	228	0.24	0.10	0.10	434.235	86	85	245	84	1.0	4.0
	10/11:30			0.30	0.24	0.24		89	87	252	71	3.0	4.0
2	15/11:35	249	300	0.73	0.58	0.58	436.4	91	88	258	64	3.8	3.5
3	30/11:50	249	300	0.96	0.76	0.76	443.1	94	90	260	63	4.5	4.0
4	45/12:05	247	301	1.15	0.90	0.90	450.8	91	89	257	64	5.0	4.0
5	60/12:20	248	301	1.20	0.94	0.94	458.3	93	91	258	65	5.6	4.1
6	75/12:35	247	304	1.20	0.94	0.94	466.5	94	91	259	69	6.0	3.8
7	90/12:50	249	306	1.10	0.86	0.86	474.7	95	92	261	70	6.3	3.9
8	105/13:05	249	311	1.10	0.86	0.86	482.6	96	93	261	65	7.0	4.4
9	120/13:20	248	313	1.10	0.86	0.86	490.7	95	92	259	68	8.0	4.3
10	135/13:35	250	316	1.10	0.86	0.86	498.9	94	92	259	70	7.5	4.1
11	150/13:50	249	316	0.86	0.70	0.70	507.1	92	91	255	78		
12	165/14:05	248	317	0.78	0.62	0.62	514.4						
	180/14:20	off					521.940						
1	180/15:53	on		0.23	0.18	0.18	521.948						
TOTAL	198/15:56	power off					522.178						
AVERAGE													

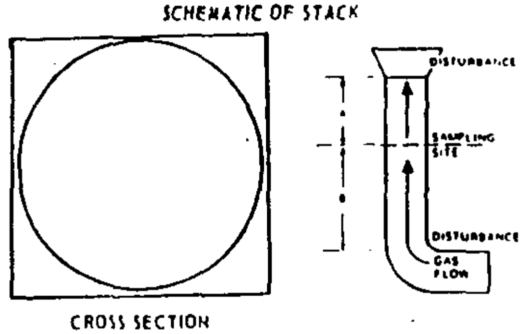
VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS

72

PARTICULATE FIELD DATA



PLANT Niles Ohio Ohio Edison

DATE 7/27/93

LOCATION ESP inlet

OPERATOR Leonard, Hupp

STACK NO.

RUN NO. N-4-MUM-727

SAMPLE BOX NO. 1

METER BOX NO. X-40513

AMBIENT TEMPERATURE 89°

BAROMETRIC PRESSURE 28.82

ASSUMED MOISTURE, % 7

PROBE LENGTH, in. 13 ft. glass

NOZZLE DIAMETER, in. 0.182

STACK DIAMETER, in. 140"

PROBE HEATER SETTING 250°F

HEATER BOX SETTING 250°F

METER $\Delta H_@$ 1.65

C FACTOR 0.95

PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
	TOTAL	

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	probe temp °F ~~STATIC PRESSURE (in. H2O)~~	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	O_2 % ~~VELOCITY fps~~
~~2~~	~~195/16:08~~												
1	182/17:16	247	320	0.35	0.27	0.27	523.178	90	90	252	81	5.0	4.4
2	195/17:28	248	320	0.55	0.43	0.43	526.6	90	90	258	73	6.0	4.5
3	210/17:43	251	322	0.91	0.70	0.70	532.1	91	90	258	65	8.5	4.4
4	225/17:58	245	321	0.98	0.78	0.78	539.2	90	89	255	65	10.0	4.3
5	240/18:13	253	320	1.10	0.88	0.88	547.1	91	90	258	67	11.0	4.4
6	255/18:28	255	319	1.10	0.88	0.88	555.3	90	89	258	70	12.0	4.2
7	270/18:43	261	316	1.20	0.94	0.94	563.5	90	90	259	64	13.0	4.2
8	285/18:58	256	315	0.95	0.76	0.76	572.0	90	90	258	63	13.0	4.5
9	300/19:13	260	312	0.92	0.74	0.74	579.9	90	90	259	63	13.0	4.5
10	315/19:28	261	309	0.88	0.70	0.70	587.4	90	90	260	66	13.0	4.3
11	330/19:43	264	308	0.80	0.64	0.64	594.8	90	90	258	63	13.0	4.5
12	345/19:58	263	306	0.75	0.60	0.60	601.8	90	90	260	63	13.0	4.5
	360/20:13	off											
TOTAL													
AVERAGE													

heated line 2524 253°F

leak check after 0.018 at 14" Hg.

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT Stack / Hot Site
PROJECT NO. 93C0282-01
CONTROL BOX OPERATOR ZPC
BAROMETRIC PRESSURE 29.00

TEST DATE 07-27-93 (Tues)
TEST NO. N-59-Mum-727
NOZZLE (SIZE,#) 0.228
STATIC PRESSURE -1.0" H2O
PORT DIRECTION Port B

ORIFICE CORRECTION 1.650
METER CORRECTION 0.4939
CALIBRATION DATE
PITOT CORRECTION 0.84
CONTROL BOX NO. ~~38704~~

HOT BOX NO. 1
COLD BOX NO. 1
PROBE NO. 5E
FILTER NO.
STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	9:54	694.085	1.1	1.92	1.92	99	98	3.0	286	~250°F	<68°	~250°F	40 mL/CT
			1.1	1.92	1.92	99	98	3.0	289				reading since
			1.1	1.92	1.92	99	98	3.0	290				5 min
			1.1	1.92	1.92	105	98	3.0	290				
			1.1	1.92	1.92	107	92	3.0	291				
			1.0	1.75	1.75	108	92	3.0	290				
19.3			1.1	1.92	1.92	110	93	3.0	291				
			1.0	1.75	1.75	110	93	3.6	290				
~~19.3~~			1.0	1.75	1.75	111	94	3.0	291				
			1.0	1.75	1.75	111	94	3.0	290				
			1.1	1.92	1.92	111	94	3.0	290				
			1.1	1.92	1.92	113	95	3.0	289				
5.8			0.70	1.92	1.92	113	96	3.0	289				
			0.75	1.31	1.31	113	96	3.0	289				
			0.75	1.31	1.31	112	95	2.5	289				Estimates:
			0.75	1.31	1.31	112	96	2.5	290				MW= 29.6
~~5.8~~			0.75	1.31	1.31	112	96	2.0	290				%H2O= 9
	11:24	761.642	0.75	1.31	1.31	112	96	2.0	291				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	<0.01cfm
After	6.5	<0.01cfm

PITOT LEAK CHECK

	Positive	Negative
Before	0"/15 sec	0"/15 sec
After	0"/15 sec	0"/15 sec

	1	2
CO2	16.0	15.0
O2	6.0	6.0
CO	0	0
N2	79.0	79.0

Fyrite orsat O2 = 21% 11:20

Impinger No.	Impinger Dry Contents	Final	Initial	Difference
		799.5	459.2	340.3 total
1.	150 mL HNO3/H2O2	758.0	632.6	125.4
2.	150 mL HNO3/H2O2	634.8	617.7	17.1
3.	Empty	486.5	486.4	0.1
4.	100 mL KMnO4	638.8	635.3	3.5
5.	100 mL KMnO4	615.3	614.3	1.0
6.	Silica Gel	695.5	652.5	43.0

Moisture = 9.2%

536.4 g total

TIME = 90 min
VOLUME = 67.557 dcf
$(\Delta P)_{AVG}$ = 0.95

$T_{meter\ AVG}$ = 102°F

velocity = 65.5 ft/sec

KEYSTONE

AQE 2/92

STACK SAMPLING DATA SHEET

CLIENT Battelle IDOE
TEST UNIT Stack Hot Site
PROJECT NO. 93C028 - 01
CONTROL BOX OPERATOR RPC
BAROMETRIC PRESSURE 29.00

TEST DATE 07-27-93 (Tues.)
TEST NO. N-59-MUM-727
NOZZLE (SIZE,#) 0.228
STATIC PRESSURE -1.0" H2O
PORT DIRECTION Port C

ORIFICE CORRECTION 1.650
METER CORRECTION 0.9939
CALIBRATION DATE
PITOT CORRECTION 0.84
CONTROL BOX NO. Nutech ~~K-8904~~

HOT BOX NO. 1
COLD BOX NO. 1
PROBE NO. 5'
FILTER NO.
STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39 1	11:31	761.642	1.2	2.09	2.09	100	96	3.5	290	~250°F	68°F [illegible]	~250°F	30 min/PT
			1.2	2.09	2.09	107	95	3.5	290				Readings
			1.30	2.27	2.27	107	95	3.5	290				taken 5 min
			1.30	2.27	2.27	107	95	3.5	290				
			1.30	2.27	2.27	115	96	3.5	291				
			1.40	2.44	2.44	116	95	3.5	291				
19.3			1.10	1.92	1.92	116	96	3.0	292				
~~39.1~~			1.10	1.92	1.92	117	96	3.0	291				
			1.10	1.92	1.92	117	96	3.0	271				
			1.10	1.92	1.92	117	96	3.0	291				
			1.10	1.92	1.92	117	98	3.0	291				
			1.10	1.92	1.92	111	98	3.0	291				
5.8			1.10	1.92	1.92	116	98	3.0	290				
			.95	1.66	1.66	115	98	3.0	294				
			.95	1.66	1.66	115	98	3.0	295				Estimates:
~~1.9~~			.90	1.57	1.57	115	98	2.0	294				MW= 29.6
			.90	1.57	1.57	116	98	2.0	300				%H2O= 9.0
	13:01	833.130	.90	1.57	1.57	117	99	2.0	294				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	15.0	
O2	6.0	
CO	0	
N2	79.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Page #1 des
TIME = 90 min
VOLUME = 71.488 dcf
AQE 2/92 $(\Delta P)_{AVG} = 1.10$
$(\Delta H)_{AVG} = 1.94$

$(T_{meter})_{AVG} = 105°F$
$(T_{stack})_{AVE} = 292°F$

velocity = 70.6 ft/sec
Iso. = 97.5% (Y=1)

KEYSTONE

STACK SAMPLING DATA SHEET

CLIENT	Battelle / DOE	TEST DATE	07-27-93 (Tues)	ORIFICE CORRECTION	1.650	HOT BOX NO.	1
TEST UNIT	Stack - Hot Site	TEST NO.	N-59-MUM-727	METER CORRECTION	0.9939	COLD BOX NO.	1
PROJECT NO.	93C0327-01	NOZZLE (SIZE, #)	0.228	CALIBRATION DATE		PROBE NO.	5'
CONTROL BOX OPERATOR	RPC	STATIC PRESSURE	-1.0" H_2O	PITOT CORRECTION	0.84	FILTER NO.	
BAROMETRIC PRESSURE	29.00	PORT DIRECTION	Port D	CONTROL BOX NO.	Nutech ~~#~~	STACK DIA.	132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	13:13	833.130	1.1	1.92	1.92	98	97	3.0	291	~250°	68°F	~250°F	30 min/PT
			1.2	2.09	2.09	99	97	3.0	291				Remaining Box
			1.2	2.09	2.07	110	98	3.0	299				5 min
			1.0	1.75	1.75	114	98	2.5	299				
			1.0	1.75	1.75	116	100	2.5	296				
~~5.0~~			1.0	1.75	1.75	116	100	2.5	296				
19.3			1.3	2.27	2.27	117	102	3.5	297				
			1.3	2.27	2.27	117	101	3.5	297				
			1.2	2.09	2.09	118	101	3.0	297				
			1.2	2.09	2.09	119	101	3.0	296				
			1.2	2.09	2.09	119	101	3.0	297				
			.96	1.68	1.68	118	102	3.0	297				
5.8			.96	1.68	1.68	119	103	3.0	298				
			.96	1.68	1.68	119	103	3.0	296				
~~3.8~~ RPC			.95	1.66	1.66	119	103	3.0	297				Estimates:
			1.0	1.75	1.75	120	104	3.0	299				MW= 29.~~6~~
			1.0	1.75	1.75	120	104	3.0	298				%H2O= 9
	14:43	903.275	1.0	1.75	1.75	120	104	3.0	298				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	15.0	
O2	6.0	
CO	0	
N2	79.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Page #3 values:
TIME = 90 min
VOLUME = 70.145 dcf
(ΔP) AVG = 1.10

Tstack AVG = 108°F

velocity = 70.8 ft/sec
ISO. = 95.5 % (Y=1)

KEYSTONE

STACK SAMPLING DATA SHEET

CLIENT	BATTELLE /DOE	TEST DATE	07-27-93 (Tues)	ORIFICE CORRECTION	1.650	HOT BOX NO.	1
TEST UNIT	STACK - HOT SLAG	TEST NO.	N-50-MUM-727	METER CORRECTION	0.9939	COLD BOX NO.	1
PROJECT NO.	93C029-01	NOZZLE (SIZE,#)	0.228	CALIBRATION DATE		PROBE NO.	5'
CONTROL BOX OPERATOR	KPC	STATIC PRESSURE	-1.0" H2O	PITOT CORRECTION	0.84	FILTER NO.	
BAROMETRIC PRESSURE	29.00	PORT DIRECTION	PORT A	CONTROL BOX NO.	NUTECH ~~K-58904~~	STACK DIA.	132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	14:49	903.275	1.2	2.09	2.09	105	102	3.5	298	~250°F	268° Ice Bath	250°F	30 min/pt
			1.2	2.09	2.09	113	102	3.5	298				Readings Every
			1.2	2.09	2.09	116	102	3.5	299				5 min
			1.2	2.09	2.09	117	102	3.5	299				
~~77.~~			1.2	2.09	2.09	118	103	3.5	299				
			1.1	1.92	1.92	119	103	3.5	299				
19.3			1.0	1.75	1.75	120	103	3.5	298				
			1.0	1.75	1.75	120	103	3.5	296				
			1.0	1.75	1.75	121	103	3.5	298				
			1.0	1.75	1.75	121	103	3.5	299				
			1.1	1.92	1.92	122	103	3.5	298				
			1.0	1.75	1.75	123	103	3.5	298				
5.8			.90	1.57	1.57	123	103	3.5	297				
			.80	1.40	1.40	122	103	3.0	299				
			.80	1.40	1.40	122	103	3.0	299				Estimates:
			.85	1.48	1.48	120	103	3.0	299				MW= 29.86
			.85	1.48	1.48	119	103	3.0	299				%H2O= 9
	16:19	970.300	.85	1.48	1.48	119	103	3.0	296				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Rec'd #4 checked

TIME = 90 min

VOLUME = 67.025 dcf

AQE 2/92 $(\Delta P)_{AVG}$ = 1.00

(ΔH) = 1.77

Tstack avg = 111°F

velocity = 67.6 ft/sec

ISO. = 95.2% (Y=1)

KEYSTONE

STACK SAMPLING DATA SHEET

CLIENT Battelle DOE
TEST UNIT 5B
PROJECT NO. 93-C028
CONTROL BOX OPERATOR D. Brown
BAROMETRIC PRESSURE 28.94

TEST DATE 7-27-93
TEST NO. N-SB-MUM-727
NOZZLE (SIZE,#) —
STATIC PRESSURE —
PORT DIRECTION —

ORIFICE CORRECTION 1.821
METER CORRECTION 0.9649
CALIBRATION DATE 7-16-93
PITOT CORRECTION —
CONTROL BOX NO. Box 2 Portland

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. —
FILTER NO. —
STACK DIA. —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
—	0955	467.346	—	2.0	2.0	99	97	6.5	—	—	65	—	
	1005	472.6		2.0	2.0	109	98	9.0			63		
	1015	480.9		2.0	2.0	119	102	9.0			61		
	1025	489.9		2.0	2.0	124	107	9.0			57		
	1035	498.2		2.0	2.0	127	110	9.0			54		
	1045	501.6		2.0	2.0	128	113	9.0			53		
	1055	515.2		2.0	2.0	130	114	9.0			54		
	1105	523.8		2.0	2.0	131	115	9.0			52		
	1115	522.9		2.0	2.0	132	116	9.0			52		
	1125	540.8		2.0	2.0	132	117	9.0			52		
	1135	549.3		2.0	2.0	132	117	9.0			53		
	1145	558.0		2.0	2.0	132	117	9.0			54		
	1155	566.7		2.0	2.0	132	117	9.0			54		
	1205	575.0		2.0	2.0	132	118	9.0			53		
	1215	583.6		2.0	2.0	134	120	9.0			53		Estimates:
	1225	593.2		2.0	2.0	131	119	9.0			53		MW=
	1235	601.9		2.0	2.0	133	120	9.0			53		%H2O=
	1245	609.7		2.0	2.0	134	119	9.0			53		

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	10	0.012
After	15	0.010

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 2/92

KEYSTONE

STACK SAMPLING DATA SHEET

CLIENT Battelle DOE	TEST DATE 7-27-93	ORIFICE CORRECTION 1.821	HOT BOX NO. —
TEST UNIT 5B	TEST NO. N-5B-MUM-727	METER CORRECTION 0.9649	COLD BOX NO. —
PROJECT NO. 93-6028	NOZZLE (SIZE,#) —	CALIBRATION DATE 7-16-93	PROBE NO. —
CONTROL BOX OPERATOR D. Brown	STATIC PRESSURE —	PITOT CORRECTION —	FILTER NO. —
BAROMETRIC PRESSURE 28.94	PORT DIRECTION —	CONTROL BOX NO. Box 2 Portland	STACK DIA. —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
—	1255	1017.6	—	2.0	2.0	134	120	9.0	—	—	54	—	
	1305	1025.8		2.0	2.0	134	120	9.0			54		
	1315	1034.5		2.0	2.0	134	121	9.0			53		
	1325	1041.8		2.0	2.0	135	120	10.0			53		
	1335	1049.9		2.0	2.0	135	124	10.5			54		
	1345	1058.9		2.0	2.0	132	121	11.0			53		
	1355	1067.0		2.0	2.0	133	121	12.0			53		
	1405	1075.6		2.0	2.0	133	121	12.5			53		
	1415	1084.4		2.0	2.2	134	121	12.0			53		
	1425	1093.1		2.0	2.0	134	121	12.0			53		
	1435	701.8		2.0	2.0	134	121	12.0			54		
	1445	710.2		2.0	2.0	135	122	11.6			52		
	1455	718.8		2.0	2.0	135	122	11.0			52		
	1505	727.6		2.0	2.0	134	122	11.0			51		
	1515	735.4		2.0	2.0	134	122	11.0			51		Estimates:
	1525	744.8		2.0	2.0	134	122	11.0					MW=
	1535	752.5		2.0	2.0	134	122	11.0			52		%H2O=
	1545	761.0		2.0	2.0	135	122	11.0			51		

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 2/92

KEYSTONE

STACK SAMPLING DATA SHEET

CLIENT Battelle DOE
TEST UNIT 5B
PROJECT NO. 93-CO28
CONTROL BOX OPERATOR D. Brown
BAROMETRIC PRESSURE 28.94

TEST DATE 7-27-93
TEST NO. N-5B-MUM-727
NOZZLE (SIZE,#) —
STATIC PRESSURE —
PORT DIRECTION —

ORIFICE CORRECTION 1.821
METER CORRECTION 0.9649
CALIBRATION DATE 7-16-93
PITOT CORRECTION —
CONTROL BOX NO. Box 2 Portland

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. —
FILTER NO. —
STACK DIA. —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
—	1555	769.1	—	2.0	2.0	135	122	11.5	—	—	52	—	
	1605	777.6		2.0	2.0	135	122	11.5			53		
	1615	785.465		2.0	2.0	136	122	11.5			54		
													Estimates:
													MW=
													%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

KEYSTONE

AQE 2/92

/

NOMOGRAPH DATA

PLANT Niles, Ohio, Ohio Edison

DATE 7/29/93

SAMPLING LOCATION ESP inlet

N-4-MUM-729

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.65
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m_{avg.}}$	105
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	7
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.77
STATIC PRESSURE IN STACK, in. Hg (P_m ±0.073 x STACK GAUGE PRESSURE in in. H_2O)	P_s	
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1.0
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	310
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	0.85
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	1.10
C FACTOR	0.95	
CALCULATED NOZZLE DIAMETER, in.	0.235	
ACTUAL NOZZLE DIAMETER, in.	0.182	
REFERENCE Δp, in. H_2O	2.20	

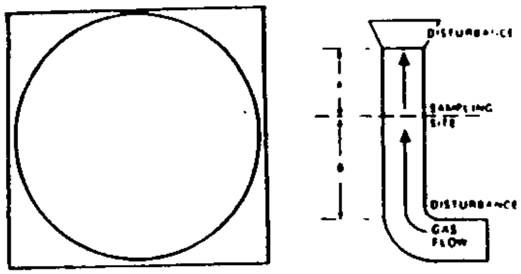
EPA (Dur) 234
4/72

Checked by:________

#1

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

PLANT Niles Ohio, Ohio Edison

DATE 7/29/93

LOCATION ESP inlet

OPERATOR Leonard Kupp

STACK NO. ______

RUN NO. N-4-MUM-729

SAMPLE BOX NO. 1

METER BOX NO. X-40513

AMBIENT TEMPERATURE 75

BAROMETRIC PRESSURE 28.77

ASSUMED MOISTURE, % 7

PROBE LENGTH, in. 12 ft.

NOZZLE DIAMETER, in. 0.184

STACK DIAMETER, in. 140"

PROBE HEATER SETTING 250°F

HEATER BOX SETTING 250°F

METER $\Delta H_@$ 1.65

C FACTOR 0.95

PROCESS WEIGHT RATE ______

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
	TOTAL	

TOP TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	probe temp °F ~~STATIC PRESSURE (in. H₂O)~~	STACK TEMPERATURE (T_S), °F	VELOCITY HEAD (ΔP_S)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	O_2 % ~~VELOCITY~~
1	0/9:26	242	2	0.38	0.30	0.30	[illegible].443	76	76	251	58	2.5	—
2	15/9:41	255	298	0.70	0.60	0.60	791.6	79	78	266	56	3.0	4.3
3	30/9:56	247	298	0.82	0.70	0.70	797.6	81	79	268	54	3.5	4.5
4	45/10:11	251	299	0.94	0.80	0.80	804.8	83	81	270	55	4.2	4.4
5	60/10:26	250	299	1.10	0.90	0.90	812.	83	81	269	55	5.0	4.5
6	75/10:41	252	299	1.10	0.90	0.90	820.6	84	82	269	57	5.2	4.4
7	90/10:56	251	301	0.85	0.70	0.70	828.6	85	83	268	61	6.0	4.6
8	105/11:11	248	306	0.90	0.74	0.74	836.4	84	83	267	64	6.0	4.4
9	120/11:26	252	308	0.90	0.74	0.74	843.7	83	82	268	65	6.5	4.5
10	135/11:41	254	310	0.90	0.74	0.74	851.0	82	81	270	62	7.0	4.5
11	150/11:56	255	311	0.72	0.60	0.60	858.5	83	82	268	65	7.0	4.4
12	165/12:11	257	311	0.64	0.54	0.54	865.1	82	81	270	55	7.2	4.4
	180/12:26	off.					871.454						
SIDE 1	180/12:40	on. 261	302	0.19	0.10	0.10	871.454	81	81	271	68	4.0	4.3
2	195/12:55	255	313	0.40	0.34	0.34	874.6	90	90	270	65	5.5	4.5
TOTAL													
AVERAGE													

heated lines 252° + 253°F

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS

77

28.76

7

0,182

METER $\Delta H_@$ 1.65

C FACTOR 0.95

PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED mg		
SAMPLE	FILTER	PROBE WASH

STACK SAMPLING DATA SHEET

CLIENT BATTELLE/DOE
TEST UNIT STACK - HOT SIDE
PROJECT NO. 93C028-01
CONTROL BOX OPERATOR LPC
BAROMETRIC PRESSURE 28.88

TEST DATE 07-29-93 (THURS.)
TEST NO. N-59-MUM-728
NOZZLE (SIZE,#) 0.228
STATIC PRESSURE -1.1" H2O
PORT DIRECTION PORT B

ORIFICE CORRECTION ~~1.650~~ 1.720
METER CORRECTION ~~0.994~~ 0.9939
CALIBRATION DATE
PITOT CORRECTION 0.84
CONTROL BOX NO. NUTECH C-10225

HOT BOX NO. 1
COLD BOX NO. 1
PROBE NO. BATTELLE 5'
FILTER NO. UNWEIGHED
STACK DIA. 132

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	09:00	970.675	1.1	2.01	2.01	85	85	3.0	291	~280°	268°F	~280°	30 min/AT
			1.1	2.01	2.01	87	85	3.0	291				READINGS
			1.1	2.01	2.01	89	86	3.0	291				every 5 min.
			1.1	2.01	2.01	98	87	3.0	290				
			1.1	2.01	2.01	99	87	3.0	291				
			1.1	2.01	2.01	107	87	3.0	291				
19.3			.95	1.74	1.74	108	87	2.5	291				
			.95	1.74	1.74	109	87	2.5	291				
			.95	1.74	1.74	106	85	2.5	291				
			.95	1.74	1.74	105	89	2.5	290				
			.95	1.74	1.74	105	89	2.5	290				
			.95	1.74	1.74	106	90	2.5	290				
5.8			.85	1.55	1.55	106	90	2.0	290				
			.85	1.55	1.55	106	90	2.0	290				Estimates:
			.75	1.37	1.37	107	90	2.0	291				MW= 29.5
			.75	1.37	1.37	107	90	2.0	291				%H2O= 9.0
			.75	1.37	1.37	107	90	2.0	291				
	10:30	1038.711	.75	1.37	1.37	109	90	2.0	291				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	<0.01 cfm
After	5.0	<0.015 cfm

PITOT LEAK CHECK

	Positive	Negative
Before	0"/15sec	0"/15sec
After	0"/15sec	0"/15sec

	~~1~~	2
CO2	14.5	14.5
O2	6.5	6.5
CO	0	0
N2	79.0	79.0

Fyrite check 20.5

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	Empty	817.1	459.2	357.9
2.	150ml HNO3/H2O2	756.3	631.2	125.1
3.	150ml HNO3/H2O	642.2	617.6	24.6
4.	Empty	486.5	481.0	5.5
5.	100ml KMnO4	637.4	636.5	0.9
6.	100ml KMnO4	620.7	615.6	5.1
7.	Silica Gel	701.8	656.2	45.6

564.7 total

Actual Moisture 9.4%

Bag #1 values

TIME = 90 min
VOLUME = 68.036 dcf
$(\Delta P)_{AVG}$ = 0.95
$(\Delta H)_{AVG}$ = 1.73

T... -95°F at 14:10 ... AIF ... = 1.58 ... = 100.6%

KEYSTONE

AQE 2/92

STACK SAMPLING DATA SHEET

CLIENT BATTELLE / DOE	TEST DATE 07-29-93 (THUR)	ORIFICE CORRECTION ~~1.650~~ 1.720 RAC	HOT BOX NO. 1
TEST UNIT STACK - HOT SIDE	TEST NO. N-59-MUM-729	METER CORRECTION ~~0.994~~ 0.9934	COLD BOX NO. 1
PROJECT NO. 93C028-01	NOZZLE (SIZE, ID) 0.228	CALIBRATION DATE	PROBE NO. BATTELLE 5'
CONTROL BOX OPERATOR RPC	STATIC PRESSURE -1.1" H_2O	PITOT CORRECTION 0.84	FILTER NO. UNWEIGHED
BAROMETRIC PRESSURE 28.88	PORT DIRECTION PORT C	CONTROL BOX NO. NUTECH #C70285	STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	10:35	1038.711	1.2	2.19	2.19	89	89	3.5	290	~250°F	68° / 20 [illegible]	~250°F	30 min/pt
			1.2	2.19	2.19	91	89	3.5	292				readings every
			1.2	2.19	2.19	105	90	3.5	291				5 min
			1.2	2.18	2.19	105	90	3.5	292				
			1.2	2.19	2.19	106	91	3.5	292				
			1.2	2.19	2.19	107	91	3.5	291				
19.3			1.2	2.19	2.19	108	92	3.5	291				
			1.2	2.19	2.19	108	92	3.5	291				
			1.2	2.19	2.19	109	92	3.5	291				
			1.2	2.19	2.19	108	92	3.5	291				
			1.1	2.01	2.01	109	91	3.0	290				
			1.1	2.01	2.01	110	91	3.0	293				
5.8			1.0	1.83	1.83	109	91	3.0	294				
			1.0	1.83	1.83	109	91	3.0	291				
			.95	1.74	1.74	107	93	3.0	295				Estimates:
			1.0	1.83	1.83	109	91	3.0	294				MW= 29.1
			1.0	1.83	1.83	108	92	3.0	~~298~~				%H2O= 9.0
	12:05	1111.271	.95	1.69	1.69	101	93	3.0	295				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	14.5	
O2	6.5	
CO	0	
N2	79.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Page #2 values:
TIME = 90 min
VOLUME = 72.560 dcf
(ΔP)avg = 1.10
(ΔH) = 2.00 [illegible]
(T m) = 99°F (T stack) = 292°F
velocity = 70.9 ft/sec
ISO = 99.1%

KEYSTONE

QE 2/92

STACK SAMPLING DATA SHEET

CLIENT Battelle/DOE
TEST UNIT Stack - Hot Side
PROJECT NO. 93C028-01
CONTROL BOX OPERATOR RPC
BARMETRIC PRESSURE 28.88

TEST DATE 07-29-93 (Thurs)
TEST NO. N-5G-MUM-729
NOZZLE (SIZE,#) 0.228
STATIC PRESSURE -1.1" H_2O
PORT DIRECTION Bet D

ORIFICE CORRECTION ~~1.64~~ orc 1.720
METER CORRECTION ~~0.994~~ 0.9939
CALIBRATION DATE
PITOT CORRECTION 0.84
CONTROL BOX NO. Nutech # C-10285

HOT BOX NO. 1
COLD BOX NO. 1
PROBE NO. Battelle 5'
FILTER NO. Unweighed
STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	12.16	111.271	1.2	2.14	2.14	93	90	3.5	294	~280	268°C ...	250°F	30 min/PT
			1.2	2.14	2.14	97	90	3.5	294				Readings
			1.2	2.14	2.14	101	90	3.5	295				Taken 5 min.
			1.2	2.14	2.14	106	90	3.5	295				
			1.2	2.14	2.14	107	92	3.5	296				
			1.1	1.96	1.96	108	92	3.0	292				
19.3			1.2	2.14	2.14	108	92	3.0	293				
			1.2	2.14	2.14	108	93	3.5	294				
			1.2	2.14	2.14	108	92	3.5	295				
			1.2	2.14	2.14	109	93	3.5	295				
			1.3	2.32	2.32	109	93	3.5	295				
			1.3	2.32	2.32	109	93	3.5	295				
5.8			.95	1.69	1.69	108	93	3.0	295				
			.95	1.69	1.69	109	93	3.0	294				
			.95	1.69	1.69	109	94	3.0	295				Estimates:
			.95	1.69	1.69	109	94	3.0	294				MW= 29.1
			.95	1.68	1.69	109	94	3.0	294				%H2O= 9.0
	13:46	184.672	.95	1.68	1.69	109	94	3.0	294				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	14.5	
O2	6.5	
CO	0	
N2	79.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Bag #3 values
TIME = 90 min
VOLUME = 73.401 dcf
$(\Delta P)_{AVG} = 1.10$
$(\Delta H)_{AVG} = 2.00$

$(T_{meter})_{AVG} = 99°F$
$(T_{stack})_{AVG} = 294°F$

velocity = 71.0 ft/sec
ISO. = 100.3%

AQE 2/92

KEYSTONE

STACK SAMPLING DATA SHEET

CLIENT BATTELLE / POR
TEST UNIT STACK - HOT SIDE
PROJECT NO. 93C028-01
CONTROL BOX OPERATOR RPC
BARMETRIC PRESSURE 28.88

TEST DATE 07-29-93 (THUR)
TEST NO. N-59-MUM-729
NOZZLE (SIZE,in) 0.228
STATIC PRESSURE -1.1" H2O
PORT DIRECTION PORT A

ORIFICE CORRECTION ~~1.650~~ 1.720
METER CORRECTION ~~0.994~~ 0.9939
CALIBRATION DATE
PITOT CORRECTION 0.84
CONTROL BOX NO NUTECH #C-10785

HOT BOX NO. 1
COLD BOX NO. 1
PROBE NO. BATTELLE 5'
FILTER NO. UNWEIGHED
STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	1359	184.672	1.2	2.14	2.14	96	91	3.5	273	~250°F	<68°F [illegible]	250°F	30 min / PT
			1.2	2.14	2.14	103	91	3.5	273				READINGS
			1.1	1.96	1.86	107	92	3.5	295				[illegible] 5 min
			1.1	1.96	1.96	106	95	3.5	273				
			1.1	1.96	1.96	106	95	3.5	299				
			1.1	1.96	1.96	108	93	3.5	298				
A 3			1.1	1.96	1.96	108	93	3.5	296				
			1.0	1.78	1.78	108	93	3.5	296				
			1.0	1.78	1.78	108	93	3.5	294				
			1.0	1.78	1.78	109	94	3.5	295				
			1.0	1.78	1.78	109	94	3.5	294				
			1.0	1.78	1.70	108	95	2.5	296				
5.8			.75	1.34	1.34	109	94	3.0	295				
			.75	1.34	1.34	109	95	3.0	296				
			.75	1.34	1.34	109	94	3.0	295				Estimates:
			.75	1.34	1.34	109	95	3.0	295				MW= 29.1
			.75	1.34	1.34	110	95	3.0	300				%H2O= 9.0
	15:29	252.070	~~.75~~	1.34	1.34	112	96	3.0	299				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	14.5	14.5
O2	6.5	6.5
CO	0	0
N2	79.0	79.0

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Page #4 calc
TIME = 90 min
VOLUME = 67.398 dcf
$(\Delta P)_{AVG} = 0.95$

velocity = 66.0 ft/sec
ISO. = 98.9 %

AQE 2/92

KEYSTONE

STACK SAMPLING DATA SHEET

CLIENT Battelle DOE
TEST UNIT 5B
PROJECT NO. 93 1029
CONTROL BOX OPERATOR D. Bruun
BAROMETRIC PRESSURE 28.88

TEST DATE 7-29-93
TEST NO. N-5B-MUM-729
NOZZLE (SIZE,#) —
STATIC PRESSURE —
PORT DIRECTION —

ORIFICE CORRECTION 1.821
METER CORRECTION Y=.9649
CALIBRATION DATE 7-16-93
PITOT CORRECTION —
CONTROL BOX NO. Box 2 Portland

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. —
FILTER NO. —
STACK DIA. —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
—	0900	096.958	—	2.2	2.2	98	95	11.0	—	—	65	—	
	0910	105.6		2.2	2.2	106	96	11.0			64		
	0920	114.4		2.2	2.2	115	99	11.0			61		
	0930	123.2		2.2	2.2	117	101	11.0			60		
	0940	131.6		2.2	2.2	120	105	11.0			59		
	0950	140.7		2.2	2.2	124	108	11.0			58		
	1000	149.6		2.2	2.2	126	110	11.0			57		
	1010	158.7		2.2	2.2	127	111	10.0			54		
	1020	167.1		2.2	2.2	128	112	10.0			54		
	1030	176.1		2.2	2.2	128	113	10.0			54		
	1040	184.6		2.2	2.2	128	113	10.0			65		
	1050	193.4		2.2	2.2	128	113	10.0			53		
	1100	202.1		2.2	2.2	129	113	10.0			~~49~~ 52		
	1110	210.9		2.2	2.2	128	113	10.0			52		
	1120	219.2		2.2	2.2	128	113	10.0			52		Estimates:
	1130	228.2		2.2	2.2	129	114	10.0			52		MW=
	1140	236.1		2.2	2.2	129	114	10.0			51		%H2O=
	1150	245.8		2.2	2.2	129	114	10.0			51		

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	15	0.001
After	15	0.001

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 2/92

KEYSTONE

KEYSTONE ENVIRONMENTAL RESOURCES / AIR QUALITY ENGINEERING
STACK SAMPLING DATA SHEET

CLIENT	Battelle DOS	TEST DATE	7-29-93	ORIFICE CORRECTION (ΔH@)	1.821
TEST UNIT	5B	TEST NO.	N-5B-MVM-729	METER CORRECTION (Y)	.9649
PROJECT NO.	93C028	NOZZLE (SIZE,#)		CALIBRATION DATE	7-16-93
TEST CREW	D. Brown	STATIC PRESSURE	—	PITOT CORRECTION	—
BAROMETRIC PRESSURE	28.88	PORT DIRECTION	—	CONTROL BOX NO.	Box 2 Portland

HOT/COLD BOX NO.	—
PROBE NO.	—
FILTER NO.	—
STACK DIA.	—
PORT SIZE	—

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Required (in. H2O)	Orifice ΔH Actual (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°F)	Hot Box Temp. (°F)	Comments
—	1200	254.7	—	2.2	2.2	129	114	10.0	—	54	—	—	min./point
	1210	262.9		2.2	2.2	129	114	10.0		54			
	1220	272.1		2.2	2.2	129	114	10.0		54			
	1230	280.6		2.2	2.2	129	114	10.0		54			
	1240	288.9		2.2	2.2	129	114	10.0		54			
	1250	297.6		2.2	2.2	129	114	10.0		54			
	1300	306.9		2.2	2.2	129	114	10.0		52			
	1310	315.3		2.2	2.2	129	114	10.0		52			
	1320	324.1		2.2	2.2	129	114	10.0		52			
	1330	333.6		2.2	2.2	129	114	10.0		52			
	1340	341.5		2.2	2.2	129	114	10.0		52			
	1350	349.6		2.2	2.2	130	115	10.0		54			
	1400	358.2		2.2	2.2	130	115	10.0		55			
	1410	367.7		2.2	2.2	130	115	10.0		52			
	1420	376.2		2.3	2.2	130	115	10.0		52			
	1430	385.0		2.2	2.2	130	115	10.0		54			Estimates:
	1440	394.7		2.2	2.2	130	115	10.0		54			MW=
	1450	403.6		2.2	2.2	170	115	10.0					%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		
GAS	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 6/92

KEYSTONE ENVIRONMENTAL RESOURCES / AIR QUALITY ENGINEERING
STACK SAMPLING DATA SHEET

CLIENT Battelle DOE
TEST UNIT 5B
PROJECT NO. 931028
TEST CREW D. Brown
BAROMETRIC PRESSURE 28.88

TEST DATE 7-29-93
TEST NO. N-5B-MUM-729
NOZZLE (SIZE,#) —
STATIC PRESSURE —
PORT DIRECTION —

ORIFICE CORRECTION (ΔH@) 1.821
METER CORRECTION (Y) 0.9649
CALIBRATION DATE 7-16-93
PITOT CORRECTION —
CONTROL BOX NO. Box 2 Portland

HOT/COLD BOX NO. —
PROBE NO. —
FILTER NO. —
STACK DIA. —
PORT SIZE —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Required (in. H2O)	Orifice ΔH Actual (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°F)	Hot Box Temp. (°F)	Comments
—	1500	411.273	—	2.2	2.2	130	115	10	—	—	54	—	min./point
													Estimates:
													MW=
													%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		
GAS	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 6/92

NOMOGRAPH DATA

PLANT Niles, Ohio, Ohio Edison

DATE 7/31/93

SAMPLING LOCATION ESP inlet

N-4-MUM-731

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.65
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m_{avg.}}$	95
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	7
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.92
STATIC PRESSURE IN STACK, in. Hg (P_m ±0.073 x STACK GAUGE PRESSURE in in. H_2O)	P_s	
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1.0
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	310
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	0.85
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	1.10
C FACTOR	0.90	
CALCULATED NOZZLE DIAMETER, in.	0.240	
ACTUAL NOZZLE DIAMETER, in.	0.182	
REFERENCE Δp, in. H_2O	2.20	

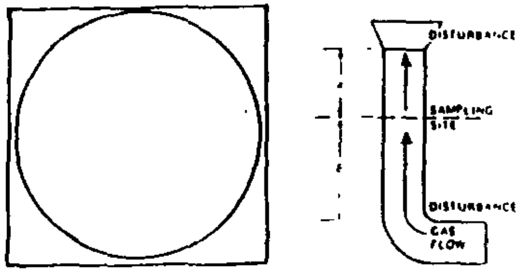
EPA (Dur) 234
4/72

Checked by:__________

#1

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

PLANT Niles, Ohio, Ohio Edison
DATE 7/31/93
LOCATION ESP inlet
OPERATOR Leonard, Hupp
STACK NO.
RUN NO. N-4-MUM-731
SAMPLE BOX NO. 1
METER BOX NO. X-40513

AMBIENT TEMPERATURE 66°F
BAROMETRIC PRESSURE 28.92
ASSUMED MOISTURE, % 7
PROBE LENGTH, in. 13 Ft. glass
NOZZLE DIAMETER, in. 0.182
STACK DIAMETER, in. 140"
PROBE HEATER SETTING 250°F
HEATER BOX SETTING 250°F

METER $\Delta H_@$ 1.66
C FACTOR 0.90
PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	Probe Temp. °F ~~STATIC PRESSURE (in. H₂O)~~	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	O₂ % ~~VELOCITY~~
1	0/9:00	247	269	0.51	0.39	0.39	112.482	69	69	267	58	3.5	4.1
2	15/9:15	248	290	0.55	0.42	0.42	118.4	71	70	264	51	3.5	4.0
3	30/9:30	250	292	0.88	0.68	0.68	124.0	73	72	268	51	5.0	3.8
4	45/9:45	249	294	1.10	0.84	0.84	131.0	75	73	267	50	5.5	3.8
5	60/10:00	248	294	1.10	0.84	0.84	138.5	76	74	265	52	6.0	3.6
6	75/10:15	255	296	1.10	0.84	0.84	146.4	76	75	266	53	7.0	3.6
7	90/10:30	255	297	0.90	0.70	0.70	154.7	77	75	265	56	7.5	4.0
8	105/10:45	257	302	0.90	0.70	0.70	163.2	78	76	263	55	5.5	3.9
9	120/11:00	257	305	0.95	0.72	0.72	170.4	79	77	265	57	21.0	
9	133/11:13	off nozzle plugged					173.2						
9	133/11:23	on		0.95	0.72	0.72	173.2					5.5	
10	135/11:25	235	307	0.96	0.72	0.72	174.3	77	77	263	63	5.5	4.0
10	138/11:28	off coal feeder problem					176.664						
10	138/11:32	on 252	305	0.96	0.72	0.72	176.664	78	78	269	66	6.0	5.2
11	150/11:44	258	310	0.80	0.62	0.62	182.8	80	79	268	54	5.5	4.0
TOTAL													
AVERAGE													

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME, ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

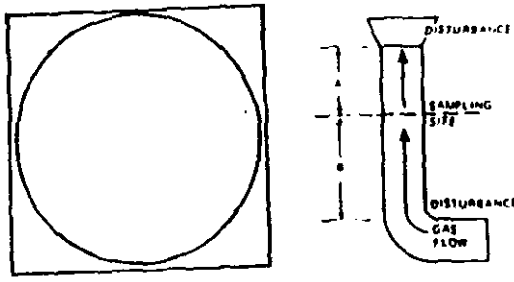
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS

#2

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

PLANT Niles, Ohio, Ohio Edison
DATE 7/31/93
LOCATION ESP inlet
OPERATOR Leonard Hupp
STACK NO.
RUN NO. N-4-MVM-731
SAMPLE BOX NO. 1
METER BOX NO. X-40513

AMBIENT TEMPERATURE 66
BAROMETRIC PRESSURE 28.93
ASSUMED MOISTURE, % 7
PROBE LENGTH, in. 13 ft
NOZZLE DIAMETER, in. 0.182
STACK DIAMETER, in. 140"
PROBE HEATER SETTING 250°F
HEATER BOX SETTING 250°F

METER ΔH@ 1.60
C FACTOR 0.90
PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	probe temp °F ~~STATIC PRESSURE (in. H₂O)~~	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	O_2 % ~~VELOCITY~~
12	165/11:59	263	311	0.71	0.54	0.54	189.7	80	79	265	54	6.5	4.1
	180/12:14	off					196.582						
1	180/12:40	on 267	297	0.15	0.12	0.12	196.582	79	78	266	72	3.0	4.0
2	195/12:56	260	314	0.50	0.39	0.39	199.7	80	80	260	66	4.5	3.8
3	210/13:10	260	315	0.91	0.70	0.70	205.4	82	81	267	57	6.5	4.2
4	225/13:25	255	317	1.10	0.84	0.84		82	81	269	51	7.5	4.1
5	240/12:40	256	312	1.10	0.84	0.84	221.2	83	82	267	54	9.0	
6.5	245/13:15	stop, sheared pin.											
5	245/13:52	on											
6	255/14:02	256	310	1.10	0.84	0.84	228.5	84	83	270	53	10.0	4.2
7	270/14:17	255	311	0.98	0.77	0.77	236.7	85	83	269	56	9.0	4.2
8	285/14:32	255	307	0.98	0.77	0.77	244.9	85	84	269	62	9.0	4.0
9	300/14:47	257	304	0.96	0.76	0.76	253.6	87	85	271	64	9.0	4.3
10	315/15:02	258	301	0.91	0.70	0.70	261.2	86	85	270	58	8.5	4.2
11	330/15:17	260	301	0.84	0.66	0.66	269.1	87	86	268	57	8.0	4.2
TOTAL													
AVERAGE													

heated lines 152/152°F

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

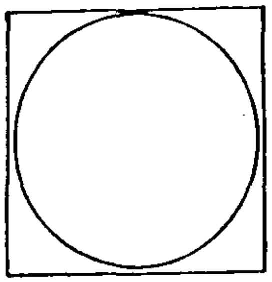
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS

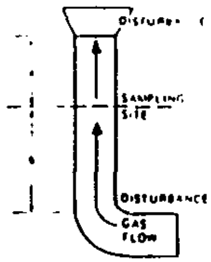
#3

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION



PLANT: Niles, Ohio Ohio Edison
DATE: 7/31/93
LOCATION: ESP inlet
OPERATOR: Leonard, Hupp
STACK NO.:
RUN NO.: N-4-MUM-731
SAMPLE BOX NO.: 1
METER BOX NO.: X-40513

AMBIENT TEMPERATURE: 82°
BAROMETRIC PRESSURE: 28.93
ASSUMED MOISTURE, %: 7
PROBE LENGTH, in.: 13 ft.
NOZZLE DIAMETER, in.: 0.182
STACK DIAMETER, in.: 140"
PROBE HEATER SETTING: 250°F
HEATER BOX SETTING: 250°F

METER $\Delta H_@$: 1.65
C FACTOR: 0.90
PROCESS WEIGHT RATE:

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
	TOTAL	

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	probe temp °F ~~STATIC PRESSURE (in. H_2O)~~	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	O_2 % ~~VELOCITY ft/s~~
12	345/15:32	264	300	0.66	0.50	0.50	276.6	87	86	272	61	7.0	
	360/15:47	off					284.285						
TOTAL													
AVERAGE													

fitting broke trying for final leak check

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					—
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS

4th imp. inlet elbow broken into several pcs.

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT Stack Hot Side
PROJECT NO. 93CD28-01
CONTROL BOX OPERATOR RPC
BAROMETRIC PRESSURE 29.06

TEST DATE 07-31-93 (Sat.)
TEST NO. N-5G-MUO-731
NOZZLE (SIZE,#) 0.228
STATIC PRESSURE -1.1" H2O
PORT DIRECTION Port B

ORIFICE CORRECTION 1.720
METER CORRECTION 0.9939
CALIBRATION DATE
PITOT CORRECTION 0.84
CONTROL BOX NO. Nutech #C-10285

HOT BOX NO. 1
COLD BOX NO. 1
PROBE NO. Battelle 5'
FILTER NO.
STACK DIA. 132'

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	09:05	253.386	1.1	1.96	1.96	78	78	5.0	286	~250°	<68°F Iced	~250°	30 min / pt
			1.1	1.96	1.96	84	79	5.0	286				5 min / readings
			1.0	1.78	1.78	85	80	5.0	286				
			1.0	1.78	1.78	95	80	5.0	290				
			1.0	1.78	1.78	97	85	5.0	286				
			1.0	1.78	1.78	97	83	5.0	285				
19.3			.95	1.69	1.68	99	84	4.5	289				
			.95	1.69	1.69	99	84	4.5	290				
			.95	1.69	1.69	99	84	4.5	291				
			.95	1.69	1.69	99	85	4.5	290				
			.95	1.69	1.69	99	85	4.5	289				
			.95	1.69	1.69	99	86	4.5	286				
5.8			.95	1.69	1.69	99	87	4.5	281				
			.80	1.43	1.43	99	87	4.5	281				
			.80	1.43	1.43	99	87	4.5	286				Estimates:
			.80	1.43	1.43	101	87	4.5	285				MW= 29.6
			.80	1.43	1.43	101	88	4.5	286				%H2O= 9.0
	10:35	318.585	.80	1.43	1.43	101	88	4.5	285				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	<0.0152
After	7.0	<0.01 cfm

PITOT LEAK CHECK

	Positive	Negative
Before	OK/15 sec	OK/15 sec
After	OK/15 sec	OK/15 sec

	1	2
CO2	14.0	14.0
O2	6.5	6.5
CO	0	0
N2	79.5	79.5

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	DRY	812.7	459.2	353.5
2.	150 acid H2O2	750.6	628.5	122.1
3.	150 acid H2O2	651.8	616.6	35.2
4.	DRY	483.9	480.9	3.0
5.	100 KMnO4	668.8	636.5	32.3
6.	100 KMnO4	583.1 - 617.0		-33.9
7.	Silica gel	714.1 - 667.3		46.8

539.0 total

Actual Moisture 9.4

Page #1
TIME = 90 min
VOLUME = 65.199 dcf
$(\Delta H)_{AVE}$ = 0.95
valid ADE 2/92

Fyrite Check O_2 = 20.3 at 1255
0.96 / T... L) ave = 286°F

velocity = 65.4 ft/sec
ISO = 97.8%
(Y=1)

KEYSTONE

STACK SAMPLING DATA SHEET

1.720

CLIENT Battelle / DOE	TEST DATE 07-31-93 (Sat.)	ORIFICE CORRECTION ~~1.650~~	HOT BOX NO. 1
TEST UNIT Stack Hot-Side	TEST NO. N-59-MUM-731	METER CORRECTION 0.9939	COLD BOX NO. 1
PROJECT NO. 93C028-01	NOZZLE (SIZE,#) 0.229	CALIBRATION DATE	PROBE NO. Battelle 5'
CONTROL BOX OPERATOR RPC	STATIC PRESSURE -1.1" H_2O	PITOT CORRECTION 0.84	FILTER NO. [illegible]
BAROMETRIC PRESSURE 29.06	PORT DIRECTION Port C	CONTROL BOX NO. Nutech # C-1028	STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
37.1	10:41	318.585	1.0	1.78	1.78	99	87	5.0	286	250°F	68°F [illegible]	~250°F	30 min / PT
			1.0	1.78	1.78	96	89	5.0	289				5 min/readings
			1.0	1.78	1.78	99	89	5.0	286				
			1.0	1.78	1.70	105	89	5.0	286				
			1.0	1.78	1.78	103	88	5.0	288				
			1.0	1.78	1.78	104	89	5.0	288				
9.3			1.0	1.78	1.78	104	89	5.0	289				
			1.0	1.78	1.78	104	89	5.0	290				
			1.0	1.78	1.78	104	89	5.0	291				
			1.0	1.78	1.78	104	90	5.0	291				
			1.0	1.78	1.78	105	90	5.0	290				
			1.0	1.78	1.78	105	90	5.0	290				
5.8			.95	1.69	1.69	105	90	5.0	291				
			.95	1.69	1.69	105	90	5.0	290				
			.95	1.69	1.69	105	90	5.0	291				Estimates:
			.95	1.69	1.69	105	90	5.0	291				MW= 28.5
			.95	1.69	1.69	105	91	5.0	290				%H2O= 9.0
	12:11	385.920	.95	1.69	1.69	105	91	5.0	291				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	14.0	
O2	6.5	
CO	0	
N2	79.5	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Page #2 values

TIME: 90 min

VOLUME: 67.335 dcf

$(\Delta P)_{AVG} = 1.00$

$(\Delta H)_{AVG} = 1.75$

$(T_{meter})_{AVG} = 96°F$ $(T_{stack})_{AVG} = 289°F$

velocity = 67.2 ft/sec

ISO. = 97.6% (Y=1)

KEYSTONE

AQE 2/92

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT Stack - Hot Side
PROJECT NO. 93C028-01
CONTROL BOX OPERATOR RPC
BAROMETRIC PRESSURE 29.06

TEST DATE 07-31-93 (Sat.)
TEST NO. N-59-MUM-731
NOZZLE (SIZE,#) 0.228
STATIC PRESSURE -1.1" H2O
PORT DIRECTION Port 1

ORIFICE CORRECTION ~~1.650~~ 1.720
METER CORRECTION 0.9939
CALIBRATION DATE
PITOT CORRECTION 0.84
CONTROL BOX NO. Nutech # C-10285

HOT BOX NO. 1
COLD BOX NO. 1
PROBE NO. Battelle 5
FILTER NO. Unweighed
STACK DIA. 132

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	12.25	385.920	1.2	2.14	2.14	90	89	5.5	289	~250°F	<68°F 320 Down	~250°F	30 min/pt
			1.2	2.14	2.14	99	90	5.5	288				5 min / reading
			1.2	2.14	2.14	99	90	5.8	289				
			1.2	2.14	2.14	105	90	5.5	291				
			1.2	2.14	2.14	105	90	5.8	291				
			1.2	2.14	2.14	105	90	5.5	283				
A.3			1.1	1.96	1.96	106	90	5.5	286				
			1.1	1.96	1.96	106	90	5.5	286				
			1.1	1.96	1.96	106	90	5.5	289				
			1.1	1.96	1.96	106	90	5.5	289				
			1.1	1.96	1.96	107	92	5.5	290				
			1.1	1.96	1.96	107	92	5.5	291				
5.8			1.0	1.78	1.78	108	92	5.5	290				
			1.1	1.96	1.96	109	94	5.5	294				Estimates:
	1345	451.926	1.1	1.96	1.96	109	95	6.0	295		Feeder down	1:45	MW= 28.5
	1355	451.926	1.1	1.96	1.96	109	95	6.0	295			Stopped test	%H2O= 9.0
	1405		1.15	2.05	2.05	97	93	6.0	296		Started at	1355	
	~~1355~~	461.486	1.1	1.96	1.96	104	93	6.0	295				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	14.0	
O2	6.5	
CO	0	
N2	79.5	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Page #3 values
TIME = 90 min
VOLUME = 75.566 dcf
$(\Delta P)_{AVG} = 1.15$
$(\Delta H)_{AVG} = 2.02$
$(T_{meter})_{AVG} = 98°F$
$(T_{stack})_{AVG} = 290°F$

velocity = 72.1 ft/sec
Iso. = 102.0% (Y=1)

KEYSTONE

AQE 2/92

STACK SAMPLING DATA SHEET

CLIENT	BATTELLE / DOE	TEST DATE	07-31-95 (Sat.)	ORIFICE CORRECTION	~~1.650~~ 1.720 RPC	HOT BOX NO.	1
TEST UNIT	STACK HOT-SIDE	TEST NO.	N-59-MUM-731	METER CORRECTION	0.9939	COLD BOX NO.	1
PROJECT NO.	93C628-01	NOZZLE (SIZE,#)	0.288	CALIBRATION DATE		PROBE NO.	BATTELLE 5'
CONTROL BOX OPERATOR	RPC	STATIC PRESSURE	-1.1 "H_2O	PITOT CORRECTION	0.84	FILTER NO.	UNWEIGHED
BAROMETRIC PRESSURE	29.00	PORT DIRECTION	PORT A	CONTROL BOX NO.	NUTECH #	STACK DIA.	1.32'

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	14:12	461.486	1.2	2.14	2.14	97	93	6.0	296	~250	[illegible]	250	30 min/pt
			1.1	1.96	1.96	99	93	6.0	297				5 min readings
			1.1	1.96	1.96	103	93	6.0	295				
			1.1	1.96	1.96	105	93	6.0	295				
			1.1	1.96	1.96	109	94	6.0	295				
			1.1	1.96	1.96	109	95	6.0	296				
19.3			1.0	1.78	1.78	109	95	6.0	296				
			1.0	1.78	1.78	109	96	6.0	290				
			1.0	1.78	1.78	110	96	6.0	299				
			1.0	1.78	1.78	110	96	6.0	300				
			1.0	1.78	1.78	110	96	6.0	297				
			1.0	1.78	1.78	110	96	6.0	297				
5.8			.90	1.60	1.60	111	97	6.0	299				
			.90	1.60	1.60	111	97	6.0	297				
			.90	1.60	1.60	112	97	6.0	299				Estimates:
			.90	1.60	1.60	112	97	6.0	299				MW= 29.6
			1.0	1.78	1.78	112	97	6.0	298				%H2O= 9.0
	1542	530.880	.90	1.60	1.60	112	97	6.0	299				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	14.0	
O2	6.5	
CO	0	
N2	79.5	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Page #4 values
TIME = 90 min
VOLUME = 69.394 dcf
$(\Delta P)_{AVG}$ = 1.00
$(\Delta H)_{AVG}$ = 1.80
$(T_{meter})_{AVG}$ = 102°F
$(T_{stack})_{AVG}$ = 297°F
velocity = 67.6 ft/sec
ISO = 100.0% (Y=1)

AQE 2/92

KEYSTONE

1/3

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

STACK SAMPLING DATA SHEET

PLANT: Niles, Ohio
LOCATION: —
ACTIVITY NO: 93-C028
CONTROL BOX OPERATOR D. Brown
PROBE HANDLER —
CLEAN UP —

DATE: 7-31-93
TEST NO.: N-5B-MUM-731
NOZZLE: —
STATIC PRESSURE Ps: —
PORT DIRECTION: —
BAROMETRIC PRESSURE 29.02

ΔH@: 1.821
METER CORRECTION: 0.9649
PITOT CORRECTION: —
CONTROL BOX NO.: ~~BOX~~ 2 Portl
NOMOGRAPH SET POINT: —
LENGTHS OF UMBILICAL — x 25' — x 50'

HOT BOX NO.: —
COLD BOX NO.: —
PROBE NO.: —
FILTER NO.: —
STACK DIA.: —

Point	Time	Meter Reading (dry) CF	Velocity HO In. H_2O	Orifice ΔH In. H_2O Req.	Orifice ΔH In. H_2O Act.	Meter Temp., T_m °F In	Meter Temp., T_m °F Out	Vacuum V_m In. Hg	Stack Temp. T_s °F	Probe Temp. T_p °F	Imp. Temp. T_I °C/°F	Hot Box Temp. T_H °F	Comments
	0905	728.235		~~83~~ 2.4	~~86~~ 2.4	87	84	9			64		
	0915	736.5		~~92~~	2.4	98	85	12			59		
	0925	745.4		2.4	2.4	104	89	12			56		
	0935	755.9		2.4	2.4	110	96	12			54		
	0945	765.1		2.4	2.4	112	97	12			53		
	0955	774.4		2.4	2.4	114	98	12			53		
	1005	782.1		2.4	2.4	115	99	12			53		
	1015	791.8		2.4	2.4	116	101	12			53		
	1025	802.1		2.4	2.4	117	102	12			51		
	1035	810.2		2.4	2.4	118	103	12			49		
	1045	819.8		2.4	2.4	118	104	12			47		
	1055	829.6		2.4	2.4	118	105	12			45		
	1105	838.4		2.4	2.4	119	105	12			45		
	1115	847.6		2.4	2.4	120	105	12			42		
	1125	856.4		2.4	2.4	120	105	12			41		
	1135	867.6		2.4	2.4	121	106	12			39		

LEAK CHECK

	In Hg	Rate
Before	12	0.008
	—	0.009

ORSAT

	1	2	3
CO_2			
O_2			
CO			
N			

Impinger No.	Final	Initial	Difference
1			
2			
3			
4			
5			

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

STACK SAMPLING DATA SHEET

3/2

PLANT: Niles, Ohio DATE: 7-31-93 ΔH@: 1.821 HOT BOX NO.: —

LOCATION: — TEST NO.: N-5B-MUM-731 METER CORRECTION: 0.9649 COLD BOX NO.: —

ACTIVITY NO: 93C028 NOZZLE: — PITOT CORRECTION: — PROBE NO.: —

CONTROL BOX OPERATOR D. Brass STATIC PRESSURE Ps: — CONTROL BOX NO.: Box 2 Portland FILTER NO.: —

PROBE HANDLER — PORT DIRECTION: — NOMOGRAPH SET POINT: — STACK DIA.: —

CLEAN UP — BAROMETRIC PRESSURE 29.02 LENGTHS OF UMBILICAL — x 25' — x 50'

Point	Time	Meter Reading (dry) CF	Velocity HO In. H_2O	Orifice ΔH In. H_2O Reg.	Orifice ΔH In. H_2O Act.	Meter Temp., T_m °F In	Meter Temp., T_m °F Out	Vacuum V_m In. Hg	Stack Temp. T_s °F	Probe Temp. T_p °F	Imp. Temp. T_I °C/°F	Hot Box Temp. T_H °F	Comments
	1145	878.2		2.4	2.4	121	106	11			38		
	1155	885.1		2.4	2.4	121	106	11			37		
	1205	894.2		2.4	2.4	122	107	11			36		
	1215	903.4		2.4	2.4	122	108	11			37		
	1225	912.4		2.4	2.4	123	108	11			38		
	1235	921.2		2.4	2.4	123	108	11			38		
	1245	930.1		2.4	2.4	123	108	11			38		
	1255	929.8		2.4	2.4	120	108	11			38		
	1305	938.4		2.4	2.4	121	108	11			39		
	1315	937.2		2.4	2.4	122	108	11			40		
	1325	946.2		2.4	2.4	121	108				41		
	1335	975.9		2.4	2.4	121	108				41		
	1345	985.2		2.4	2.4	121	108				41		Shutdown
	~~1355~~												
	~~1405~~												

LEAK CHECK

	In Hg	Rate
Before		
After		

ORSAT

	1	2	3
CO_2			
O_2			
CO			
N			

Impinger No.	Final	Initial	Difference
1			
2			
3			
4			
5			

KEYSTONE
ENVIRONMENTAL RESOURCES, INC.

STACK SAMPLING DATA SHEET

PLANT: Niles, Ohio
LOCATION: —
ACTIVITY NO: 931023
CONTROL BOX OPERATOR D. Brown
PROBE HANDLER —
CLEAN UP —

DATE: 7-31-93
TEST NO.: N-SB-MMM-731
NOZZLE: —
STATIC PRESSURE Ps: —
PORT DIRECTION: —
BAROMETRIC PRESSURE 29.02

ΔH@: 1.821
METER CORRECTION: 0.9649
PITOT CORRECTION: —
CONTROL BOX NO.: Brothers Box 2
NOMOGRAPH SET POINT: —
LENGTHS OF UMBILICAL — x 25' — x 50'

HOT BOX NO.: —
COLD BOX NO.: —
PROBE NO.: —
FILTER NO.: —
STACK DIA.: —

Point	Time	Meter Reading (dry) CF	Velocity HD In. H_2O	Orifice ΔH In. H_2O Req.	Orifice ΔH In. H_2O Act.	Meter Temp. T_m °F In	Meter Temp. T_m °F Out	Vacuum V_m In. Hg	Stack Temp. T_s °F	Probe Temp. T_p °F	Imp. Temp. T_I °C/°F	Hot Box Temp. T_H °F	Comments
—	1355	985.2	—	2.4	2.4	116	104	11	—	—	46	—	START
	1405	995.6		2.4	2.4	116	104	11			46		
	1415	005.1		2.4	2.4	119	105	11			47		
	1425	014.9		2.4	2.4	120	106	11			47		
	1435	024.6		2.4	2.4	121	107	11			49		
	1445	033.8		2.4	2.4	121	107	11			44		
	1455	042.6		2.4	2.4	122	107	11			43		
	1505	051.2		2.4	2.4	123	107	11			41		
	1515	060.512		2.4	2.4	124	108	11			40		

LEAK CHECK

	In Hg	Rate
Before		
After		

ORSAT

	1	2	3
CO_2			
O_2			
CO			
N			

Impinger No.	Final	Initial	Difference
1			
2			
3			
4			
5			

D-3: Anions Train (Method 26)

KEYSTONE ENVIRONMENTAL RESOURCES, INC.
AIR QUALITY ENGINEERING
[redacted] ~~EPA METHOD 5~~ SOURCE SAMPLING DATA SHEET

CLIENT DOE
TEST UNIT ESP
PROJECT NO. Niles
SYSTEM OPERATOR Kent Rennie
BAROMETRIC PRESSURE

TEST DATE 7/27/93
TEST NO. N-4-FCL-727
SITE NO. Inlet 4
STACK DIAMETER
PORT DIRECTION

DRY GAS METER NO.
METER CORRECTION (Y)
CALIBRATION DATE

Traverse Point (inches)	Clock Time	Dry Gas Meter Reading (dcf)	Buck Reading (ft³/min)	Rotameter Reading	Meter Exit Temp. (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Hot Box Temp. (°F)	Impinger Temp. (°F)	~~Probe~~ Filter Inlet Temp. (°F)	~~Comments~~ Heated Line °F
	11:30	894.030	.49	.73							
	11:35		.75	1.9	92/84	3	305	254	76/69	198	272
	11:40	900.899	.72	1.7	92/84	3	308	250	75/66	200	272
	11:45	904.495	.71	1.7	92/84	3	305	261	75/65	200	264
		920.800	.75	1.8	94/86	4.5	306	267	77/69	203	240
		934.00	.725	1.7	91/86	5.0	306	263	75/67	197	230
		947.100	.73	1.7	89/87	5.5	308	253	76/67	197	237
	End	950.755									
											Estimates:
											MW=
											%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (ft³/min)
Before	15	.02
After		

Pitot Reading
.84" of H_2O

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

FYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO2		
O2		
CO		
N2		

AQE 7/92

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT Stack - Hot Side
PROJECT NO. 93C028-01
CONTROL BOX OPERATOR JBS
BAROMETRIC PRESSURE 29.00

TEST DATE 07-27-93 (Tues)
TEST NO. N-5a-FCL-727
NOZZLE (SIZE, Ø) 0.192
STATIC PRESSURE -1.0" H_2O
PORT DIRECTION A

ORIFICE CORRECTION 1.572
METER CORRECTION 1.051
CALIBRATION DATE 7-2-93
PITOT CORRECTION 0.84
CONTROL BOX NO. 3

HOT BOX NO. 4
COLD BOX NO. 4
PROBE NO. 5-3
FILTER NO.
STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	0955	200.712	1.10	0.91	0.91	100	93	4.5	286	~250°F	<68°F	~250°F	Single Point
	1000		1.10	0.91	0.91	107	96	4.0	287				Isokinetic
	1005		1.10	0.91	0.91	114	100	4.0	289				Sampling for
	1010		1.10	0.92	0.92	116	102	3.5	289				15 Hours.
	1015		1.20	1.00	1.00	118	104	4.0	287				
	1020		1.10	0.92	0.92	119	105	3.0	287				Readings
	1025		1.10	0.92	0.92	120	107	3.0	288				every 10 min
	1030		1.10	0.92	0.92	123	108	3.0	288				
	1035		1.15	0.96	0.96	124	110	3.5	289				
	1040		1.15	0.97	0.97	125	110	3.5	289				
	1045		1.15	0.97	0.97	125	112	3.5	289				
	1050		1.15	0.97	0.97	127	112	3.5	289				
	1055		1.15	0.97	0.97	127	113	3.5	289				
	1100		1.15	0.97	0.97	128	113	3.5	289				Estimates:
	1105		1.16	0.97	0.97	128	114	3.5	289				MW= 29.8
	1110		1.15	0.97	0.97	129	114	3.5	289				%H2O= 9.0
	1115		1.15	0.97	0.97	129	115	3.5	289				
	~~1120~~ 1125	252.071	1.15	0.97	0.97	129	115	3.5	289				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	0.015
After	5.0	0.010

PITOT LEAK CHECK 15 sec

	Positive	Negative
Before	OK	OK
After		

	1	2
CO2	15.0	
O2	6.0	
CO	0	
N2	79.0	

21% O_2 - ambient air
1120 7-27-93

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100 mL HCO_3^-/CO_3^{2-}	619.3	546.3	73.0
2.	100 mL HCO_3^-/CO_3^{2-}	580.9	570.0	10.9
3.	Empty	436.4	434.0	2.4
4.	Silica Gel	670.3	656.8	13.5
5.				

Actual Moisture = 9.2%

99.8 total

TIME = 90 min
VOLUME = 51.359 dcf
$(\Delta P)_{AVG}$ = 1.15

$(T_{meter})_{avg}$ = 115°F
$(T_{stack})_{avg}$ = 288.9°F

velocity = 72.0 ft/sec
Iso = 96.0%

AQE 2/92

KEYSTONE

FCl

STACK SAMPLING DATA SHEET

CLIENT Battelle DOE
TEST UNIT SB
PROJECT NO. 93-6028
CONTROL BOX OPERATOR D. Braun
BAROMETRIC PRESSURE 28.94

TEST DATE 7-27-93
TEST NO. N-SB-M-727
NOZZLE (SIZE,#)
STATIC PRESSURE —
PORT DIRECTION —

ORIFICE CORRECTION 1.975
METER CORRECTION 0.9921
CALIBRATION DATE 7-16-93
PITOT CORRECTION —
CONTROL BOX NO. Box 1 Portland

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. —
FILTER NO. —
STACK DIA. —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
	1005	205.918		2.0	2.0	102	94	17.0			66		Pump Max
	1015	214.3		2.0	2.0	106	97	18.0			62		Sil Gel Clear
	1025	222.7		2.0	2.0	111	101	18.0			56		Possible Impinger
	1035	230.4		2.0	2.0	113	103	18.0			53		Restriction?
	1045	238.4		2.0	2.0	116	105	18.0			52		
	1055	246.6		2.0	2.0	117	108	18.0			53		
	1105	254.3		2.0	2.0	118	109	18.0			53		
	1115	262.8		2.0	2.0	118	110	18.0			53		
	1125	271.5		2.0	2.0	118	110	18.0			54		
	1135	279.66		2.0	2.0	119	111	18.0			54		

Estimates:
MW=
%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	15	0.002
After	25	0.000

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 2/92

KEYSTONE

KEYSTONE ENVIRONMENTAL RESOURCES, INC.
AIR QUALITY ENGINEERING
[redacted] ~~EPA METHOD~~ SOURCE SAMPLING DATA SHEET

CLIENT DOE
TEST UNIT ESP
PROJECT NO. Niles
SYSTEM OPERATOR Kurt Rennie
BAROMETRIC PRESSURE

TEST DATE 7/29/93
TEST NO. N-4-FCL-729
SITE NO. Inlet 4
STACK DIAMETER
PORT DIRECTION

DRY GAS METER NO.
METER CORRECTION (Y)
CALIBRATION DATE

Traverse Point (inches)	Clock Time	Dry Gas Meter Reading (dcf)	Flow Rate ~~Back~~ Reading (ft³/min)	~~Rotameter~~ Mano Reading in H2O	Meter ~~Exit~~ Temp. I (°F) E	Vacuum (in. Hg)	Stack Temp. (°F)	Hot Box Temp. (°F)	Impinger Temp. E (°F) I	~~Probe~~ Temp. Heated line (°F)	Comments Filter Inlet °F
	9:15	986.600			80/79	3.5	425	239	92/94	257	111.
	9:20	991.425	.725	1.7	86/78	2.5	361	238	85/75	259	186
	9:30	998.713	.715	1.7	86/79	3.5	331	263	77/68	255	194
	10:05	1024.482	.715	1.7	85/80	5.0	320	248	79/69	247	198
	10:30	1042.853	.725	1.7	89/80	6.5	316	251	73/62	255	202
	End	1045.511									
											Estimates:
											MW=
											%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (ft³/min)
Before	15	.01
After		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

FYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO2		
O2		
CO		
N2		

AQE 7/92

986.800

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT Stack - Hot Side
PROJECT NO. 93C028-01
CONTROL BOX OPERATOR JTS
BAROMETRIC PRESSURE 28.88

TEST DATE 7-29-93 (Thurs.)
TEST NO. N-5a - FCL - 729
NOZZLE (SIZE,in) 0.192
STATIC PRESSURE -1.1" H_2O
PORT DIRECTION A

ORIFICE CORRECTION 1.572
METER CORRECTION 1.0151
CALIBRATION DATE 7-2-93
PITOT CORRECTION 0.84
CONTROL BOX NO. 3

HOT BOX NO. #1
COLD BOX NO. #1
PROBE NO. 5-3
FILTER NO. —
STACK DIA. 132"

Traverse Point	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	0904	561.279	1.10	0.89	0.89	96	89	4.0	285	~250°F	<68°F	~250°F	Single Point
	09		1.15	0.93	0.93	104	93	3.5	287				Isokinetic
	14		1.15	0.93	0.93	108	95	3.5	287				Sampling for
	19		1.15	0.95	0.95	111	97	3.5	287				1.5 hours
	24		1.15	0.95	0.95	114	99	3.5	287				
	29		1.15	0.96	0.96	115	101	3.5	287				Reading every
	34		1.15	0.96	0.96	117	102	3.5	287				10 minutes
	39		1.15	0.96	0.96	118	104	3.6	287				
	44		1.15	0.96	0.96	119	104	3.5	287				
	49		1.20	1.00	1.00	120	106	3.5	287				
	54		1.20	1.00	1.00	121	106	3.5	288				
	59		1.20	1.01	1.01	121	107	3.5	288				
	04		1.20	1.01	1.01	122	107	3.5	288				
	09		1.20	1.01	1.01	121	108	3.5	288				
	14		1.20	1.01	1.01	122	107	3.5	289				Estimates:
	19		1.20	1.01	1.01	122	108	3.5	290				MW=29.5
1034	24		1.20	1.01	1.01	122	108	3.5	290				%H2O=9
→	29 ~~0934~~	613.103	1.20	1.01	1.01	121	108	3.5	290				

LEAK CHECK

	in. Hg	Rate (cfm)
Before	5.0	<0.02
After	5.0	0.005

	1	2
CO2	15.0	
O2	7.0	
CO	0	
N2	78.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100ml HCO3-/CO3 2-	673.4	546.4	127.0
2.	100ml HCO3-/CO3 2-	526.1	568.1	-42.0
3.	Empty	437.3	434.2	3.1
4.	Silica Gel	666.2	652.6	13.6
5.				

101.7 total

Actual Moisture 9.3

PITOT LEAK CHECK 15 sec

POS.	NEG.
OK	OK

TIME = 90 min
VOLUME = 57.824 dcf
$(\Delta P)_{AVG} = 1.15$
$(\Delta H)_{AVG} = 0.98$

$(T_{meter})_{AVG} = 110°F$
$(T_{stack})_{AVG} = 288°F$

Velocity = 72.3 ft/sec
Iso. = 97.2%

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

KEYSTONE ENVIRONMENTAL RESOURCES / AIR QUALITY ENGINEERING
STACK SAMPLING DATA SHEET

CLIENT	Battelle DOE	TEST DATE	7-29-93	ORIFICE CORRECTION (ΔH@)	1.975	HOT/COLD BOX NO.	—
TEST UNIT	5B	TEST NO.	N-5B-F11-729	METER CORRECTION (Y)	0.9921	PROBE NO.	—
PROJECT NO.	93C028	NOZZLE (SIZE,#)	—	CALIBRATION DATE	7-16-93	FILTER NO.	—
TEST CREW	D. Brown	STATIC PRESSURE	—	PITOT CORRECTION	—	STACK DIA.	—
BAROMETRIC PRESSURE	28.88	PORT DIRECTION	—	CONTROL BOX NO.	Box 1 Portland	PORT SIZE	—

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Required (in. H2O)	Orifice ΔH Actual (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°F)	Hot Box Temp. (°F)	Comments
—	0910	414.082	—	2.0	2.0	91	91	17	—	—	58	—	min./point
	0920	422.2		1.9	1.9	97	90	17			54		ΔH max 1.9
	0930	430.0		1.9	1.9	103	94	17			57		2.0
	0940	438.6		2.0	2.0	108	96	17			52		
	0950	446.4		2.0	2.0	111	100	17			53		
	1000	454.5		2.0	2.0	112	104	17			53		
	1010	463.0		2.0	2.0	113	104	17			54		
	1020	471.0		2.0	2.0	113	105	17			54		
	1030	479.3		2.0	2.0	114	105	17			55		
	1040	487.451		2.0	2.0	114	105	17			55		
													Estimates:
													MW=
													%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	15	0.000
After	20	0.001

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

GAS	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 6/92

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

AIR QUALITY ENGINEERING

[redacted] ~~EPA METHOD 61~~ SOURCE SAMPLING DATA SHEET

CLIENT DOE
TEST UNIT ESP
PROJECT NO. N.ler
SYSTEM OPERATOR Ked Renne
BAROMETRIC PRESSURE

TEST DATE 7/26/93
TEST NO. N-9-FCL-72631
SITE NO. Inlet 4
STACK DIAMETER
PORT DIRECTION

DRY GAS METER NO.
METER CORRECTION (Y)
CALIBRATION DATE

Traverse Point (inches)	Clock Time	Dry Gas Meter Reading (dcf)	Flow Rate ~~Buck~~ Reading (ft^3/min)	Rotameter Reading	Meter Exit Temp. (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Hot Box Temp. (°F)	Impinger Temp. (°F)	~~Probe~~ Heated line Temp. (°F)	Comments Filter Inlet (°F)
	9:15	83.800		.7	70/68	2	303	229	70/70	193	135
	9:20	88.210	.77	2.0	71/68	4	302	~~22~~ 232	66/62	212	158
	9:30	96.110	.75	1.9	71/69	4	301	235	65/60	245	188
	9:45	107.562	.76	2.0	71/69	5	302	252	67/61	265	207
	10:00	118.014	.78	2.1	71/70	6	302	255	67/58	275	216
	10:15	~~128~~	.77	2.0	72/71	7	302	247	66/61	251	201
		130.125			~~73/72~~			0			
	10:28	137.876	.75	2.0	73/72	7	302	244	68/62	265	207
	End	141.793									
											Estimates:
											MW=
											%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (ft^3/min)
Before	15	.01
After		

FYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO2		
O2		
CO		
N2		

AQE 7/92

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

STACK SAMPLING DATA SHEET

Page 1 of 1

CLIENT Battelle / DOE	TEST DATE 7-31-93 (Sat.)	ORIFICE CORRECTION 1.572	HOT BOX NO. #1
TEST UNIT Stack - Hot Side	TEST NO. N-5a-FCL-731	METER CORRECTION 1.0151	COLD BOX NO. #1
PROJECT NO. 93C Ø28-01	NOZZLE (SIZE,#) 0.192	CALIBRATION DATE 7-2-93	PROBE NO. 5-3
CONTROL BOX OPERATOR JPS	STATIC PRESSURE -1.1" H_2O	PITOT CORRECTION 0.84	FILTER NO. —
BAROMETRIC PRESSURE 29.06	PORT DIRECTION A	CONTROL BOX NO. 3	STACK DIA. 132"

Σ Time	Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
0	39.1	0905	925.457	1.15	0.92	0.92	87	80	4.0	282	~250°F	<68°F	~250°F	Single Point
5		10		1.15	0.92	0.92	93	82	4.0	281				Isokinetic
10		15		1.15	0.92	0.92	100	86	4.0	281				Sampling for
15		20		1.15	0.94	0.94	101	87	4.5	282				1.5 Hours
20		25		1.15	0.94	0.94	103	89	4.5	283				
25		30		1.15	0.94	0.94	105	91	4.5	283				Readings every
30		35		1.15	0.94	0.94	108	93	4.5	284				5 min
35		40		1.15	0.94	0.94	109	94	4.5	283				
36		0941 0954	945.732 945.732	1.15	0.94	0.94	101	94	4.0	284			←	Box Timer
40		58		1.15	0.94	0.94	107	95	4.0	284				shorted out
45		03		1.15	0.95	0.95	108	95	4.0	283				Down 13 min
50		08		1.15	0.95	0.95	110	95	4.0	283				
55		13		1.15	0.95	0.95	111	96	4.0	283				
60		18		1.15	0.95	0.95	112	97	4.0	284				
65		23		1.15	0.95	0.95	113	98	4.0	284				Estimates:
70		28		1.15	0.95	0.95	113	98	4.0	284				MW=29.5
75		33		1.15	0.95	0.95	114	99	4.0	284				%H2O= 9
90		1048	976.125	1.15	0.95	0.95	114	100	4.0	286				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	0.005
After	5.0	0.005

PITOT LEAK CHECK 15 sec

	Positive	Negative
Before	OK	OK
After	OK	OK

	1	2
CO2	14.5	
O2	6.0	
CO	0	
N2	79.5	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100 ml HCO₃/CO₃²⁻	624.0	547.9	76.1
2.	100 ml HCO₃⁻/CO₃²⁻	575.8	567.8	8.0
3.	Empty	437.4	434.4	3.0
4.	Silica Gel	676.3	666.2	10.1
5.				

97.2 g total

Actual Moisture 8.9%

TIME = 90 min

VOLUME = 50.668 dcf

$(\Delta P)_{AVG} = 1.15$

$(\Delta H)_{AVG} = 0.94$

$(T_{meter})_{AVG} = 99°F$

$(T_{stack})_{AVG} = 283°F$

velocity = 71.8 ft/sec

ISO. = 96.9%

KEYSTONE

AQE 2/92

KEYSTONE
ENVIRONMENTAL RESOURCES, INC.

STACK SAMPLING DATA SHEET

PLANT: Niles, Ohio
LOCATION: —
ACTIVITY NO: 93C028
CONTROL BOX OPERATOR D. Brown
PROBE HANDLER —
CLEAN UP —

DATE: 7-31-93
TEST NO.: N-5B-FU-731
NOZZLE: —
STATIC PRESSURE Ps: —
PORT DIRECTION: —
BAROMETRIC PRESSURE 29.02

ΔH@: 1.975
METER CORRECTION: .9921
PITOT CORRECTION: —
CONTROL BOX NO.: Box 1 Portland
NOMOGRAPH SET POINT: —
LENGTHS OF UMBILICAL — x 25' — x 50'

HOT BOX NO.: —
COLD BOX NO.: —
PROBE NO.: —
FILTER NO.: —
STACK DIA.: —

Point	Time	Meter Reading (dry) CF	Velocity HD in. H_2O	Orifice ΔH in. H_2O Reg.	Orifice ΔH in. H_2O Act.	Meter Temp., T_m °F In	Meter Temp., T_m °F Out	Vacuum V_m in. Hg	Stack Temp. T_s °F	Probe Temp. T_p °F	Imp. Temp. T_I °C/°F	Hot Box Temp. T_H °F	Comments
—	0905	620.482	—	2.4	2.4	81	80	15	—	—	65	—	Max ΔH
	0915	628.4		2.0	2.0	88	80	15			61		2.0
	0925	633.3		2.0	2.0	92	82	17			54		
	0935	642.6		2.0	2.0	98	86	17			50		
	0945			2.0	2.0	100	89	17			50		
	0955	658.3		2.0	2.0	102	91	17			50		
	1005			2.0	2.0	103	94	17			49		
	1015	673.4		2.0	2.0	104	95	17			49		
	1025	682.4		2.0	2.0	105	96	17			45		
	1035	690.312		2.0	2.0	105	97	17			41		

LEAK CHECK

	In Hg	Rate
Before	16	0.002
After	[illegible]	[illegible]

ORSAT

	1	2	3
CO_2			
O_2			
CO			
N			

Impinger No.	Final	Initial	Difference
1			
2			
3			
4			
5			

D-4: Ammonia Train

KEYSTONE ENVIRONMENTAL RESOURCES, INC. Page of
AIR QUALITY ENGINEERING

[redacted] ~~EPA METHOD~~ SOURCE SAMPLING DATA SHEET

CLIENT DOE
TEST UNIT ESP
PROJECT NO. Niler
SYSTEM OPERATOR Kent Rennie
BAROMETRIC PRESSURE

TEST DATE 7-27-93
TEST NO. N-4-NH4-727
SITE NO. Inlet 4
STACK DIAMETER
PORT DIRECTION

DRY GAS METER NO.
METER CORRECTION (Y)
CALIBRATION DATE

Traverse Point (inches)	Clock Time	Dry Gas Meter Reading (dcf)	Flow Rate (ft³/min)	Rotameter Reading	Meter Exit Temp. (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Hot Box Temp. (°F)	Impinger Temp. (°F)	Temp. Heated line (°F)	Filter Inlet (°F)
	15:20	973.950	.71	1.6	91/89	5	≈310	242	89/69	249	176
	15:29	981.225	.74	1.8	91/89	5.5	"	253	77/66	247	192
534 TJK	15:14	984.905	.72	1.7	91/89	"	"	257	77/67	295	193
1536	End	985.856									
											Estimates:
											MW=
											%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (ft³/min)
Before	15	.015
After		

FYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO_2		
O_2		
CO		
N_2		

AQE 7/92

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

STACK SAMPLING DATA SHEET

CLIENT Battelle 1002	TEST DATE 07-27-93 (Tues)	ORIFICE CORRECTION 1.572	HOT BOX NO. 2
TEST UNIT Stack - HOTS-06	TEST NO. N-50-NH4-727	METER CORRECTION 1.0151	COLD BOX NO. 2
PROJECT NO. 93C028-61	NOZZLE (SIZE,#) 0.192	CALIBRATION DATE 7-2-93	PROBE NO. 5-3
CONTROL BOX OPERATOR JTS	STATIC PRESSURE -1.0"H2O	PITOT CORRECTION 0.84	FILTER NO.
BAROMETRIC PRESSURE 29.00	PORT DIRECTION A	CONTROL BOX NO. 3	STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	1150	252.273	1.2	1.02	1.02	116	114	3.0	291	~250°F	<68°F	~268F	Single point
	1155		1.2	1.02	1.02	124	114	3.0	292				Isokinetic
	1200		1.2	1.02	1.02	127	115	3.0	291				sampling for
	1205		1.2	1.02	1.02	129	115	3.0	291				30 min
	1210		1.2	1.02	1.02	129	116	3.0	291				
	1215		1.2	1.02	1.02	130	116	3.0	291				Readings every
	1220	269.955											5 min
	TIME= 30 min	Δ = 17.682 dcf	$(\Delta P)_{avg}$ = 1.2	$(\Delta H)_{avg}$ =	1.02	$(T_{meter})_{avg}$ = 120°F			$(T_{stack})_{avg}$ = 291°F				
									velocity = 73.7 ft/sec				Estimates:
									Iso. = 96.3%				MW= 29.[illegible]
													%H2O= 9%

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	0.010
After	5.0	0.010

PITOT LEAK CHECK 15 sec

	Positive	Negative
Before	OK	OK
After		

	1	2
CO2	15.0	
O2	6.0	
CO	0	
N2	79.0	

21% O2 on ambient air
1120

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100mL 0.1N H2SO4	507.1	484.0	23.1
2.	100mL 0.1N H2SO4	564.9	560.3	4.6
3.	Empty	396.9	396.4	0.5
4.	Silica Gel	672.2	665.1	7.1
5.				

Actual Moisture = 9.5%
35.3 total

KEYSTONE

AQE 2/92

STACK SAMPLING DATA SHEET

CLIENT Battelle DOS
TEST UNIT 5B
PROJECT NO. 95C028
CONTROL BOX OPERATOR D. Brown
BAROMETRIC PRESSURE 28.94

TEST DATE 7-27-93
TEST NO. N-5B-NH4-727
NOZZLE (SIZE,#) —
STATIC PRESSURE —
PORT DIRECTION —

ORIFICE CORRECTION 1.975
METER CORRECTION 0.9921
CALIBRATION DATE 7-16-93
PITOT CORRECTION —
CONTROL BOX NO. Box 2 Portland

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. —
FILTER NO. —
STACK DIA. —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H20)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
—	1150	280.000	—	2.0	2.0	115	110	3.0	—	—	63	—	
	1200	288.12		2.0	2.0	125	110	3.0			61		
	1205	292.26		2.0	2.0	133	111	3.0			57		
	1210	296.23		2.0	2.0	133	112	3.0			54		
	1215	300.32		2.0	2.0	135	113	3.0			54		
	1220	304.426		2.0	2.0	136	113	3.0			53		
	~~[illegible]~~												
	~~[illegible]~~												
													Estimates:
													MW=
													%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	15	0.000
After	15	0.000

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

KEYSTONE

AQE 2/92

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KEYSTONE ENVIRONMENTAL RESOURCES, INC.
AIR QUALITY ENGINEERING
[redacted] EPA METHOD 26 SOURCE SAMPLING DATA SHEET

CLIENT DOE
TEST UNIT ESP
PROJECT NO. Niles
SYSTEM OPERATOR Kat Bonnie
BAROMETRIC PRESSURE

TEST DATE 7-29-93
TEST NO. N-4-NH9-729
SITE NO. Inlet 4
STACK DIAMETER
PORT DIRECTION

DRY GAS METER NO.
METER CORRECTION (Y)
CALIBRATION DATE

Traverse Point (inches)	Clock Time	Dry Gas Meter Reading (dcf)	Flow Rate ~~Back~~ Reading (ft^3/min)	~~Rotameter~~ Reading Mano	Meter ~~Exit~~ Temp. (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Hot Box Temp. (°F)	Impinger Temp. E (°F) I	~~Probe~~ Temp. Heated line (°F)	~~Comments~~ Filter-Inlet
	11:10	1046.100			81/81		305	212	83/82	265	93
	11:13	1048.261	.75	1.9	83/81	5	305	219	75/62	263	189
	11:15	1049.835	.75	1.5	82/81	5	305	231	77/60	263	196
	11:20	1053.396	.75	1.8	82/81	5	305	240	71/61	261	197
11:25	~~11:40~~	1057.118	.76	1.9	83/81	5	305	247	71/63	259	201
	End	1059.180									
											Estimates:
											MW=
											%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (ft^3/min)
Before	15	.016
After		

FYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 7/92

STACK SAMPLING DATA SHEET

CLIENT Battelle DOE	TEST DATE 7-29-93 (Thurs.)	ORIFICE CORRECTION 1.572	HOT BOX NO. 7
TEST UNIT Stack-Hot Side	TEST NO. N-5a-NH4-729	METER CORRECTION 1.0151	COLD BOX NO. 2
PROJECT NO. 93C028-01	NOZZLE (SIZE,in) 0.192	CALIBRATION DATE 7-2-93	PROBE NO. 5-3
CONTROL BOX OPERATOR JJS	STATIC PRESSURE -6.1" H2O	PITOT CORRECTION 0.84	FILTER NO. —
BAROMETRIC PRESSURE 28.88	PORT DIRECTION A	CONTROL BOX NO. 3	STACK DIA. 132"

Traverse Point	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	1055	613.286	1.10	0.92	0.92	112	106	2.5	290	~250°F	68°F	~250°F	Single Point
	00		1.15	0.97	0.97	118	107	2.5	290				Isokinetic
	05		1.15	0.97	0.97	120	107	2.5	290				Sampling for
	10		1.15	0.97	0.97	120	107	2.5	290				30 min
	15		1.15	0.97	0.97	121	107	2.5	290				
	20		1.15	0.97	0.97	121	108	2.5	290				Reading every
	1125	630.369											5 minutes
	Δ=30 min	Δ=17.083 dcf	$(\Delta P)_{AVG}$ = 1.15	$(\Delta H)_{AVG}$ = 0.96		$(T_{meter})_{AVG}$ = 113°F			$(T_{stack})_{AVG}$ = 290°F				
								velocity =	72.4 ft/sec				
													Estimates:
								Iso.	= 95.7%				MW= 29.5
													%H2O= 9

LEAK CHECK

	in. Hg	Rate (cfm)
Before	5.0	0.005
After	5.0	0.010

PITOT LEAK CHECK 15 sec

POS.	NEG.
OK	OK

	1	2
CO2	15.0	
O2	7.0	
CO	0	
N2	78.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100mL 0.1N H2SO4	508.8	487.3	21.5
2.	100mL 0.1N H2SO4	567.9	562.8	5.1
3.	Empty	397.3	396.0	1.3
4.	Silica Gel	676.6	672.3	4.3
5.				

32.2 g total

Actual Moisture 9.0%

KEYSTONE

KEYSTONE ENVIRONMENTAL RESOURCES / AIR QUALITY ENGINEERING
STACK SAMPLING DATA SHEET

CLIENT Battelle DOE	TEST DATE 7-29-93	ORIFICE CORRECTION (ΔH@) 1.975	HOT/COLD BOX NO. —
TEST UNIT 5B	TEST NO. N-5B-NH4-729	METER CORRECTION (Y) 0.9921	PROBE NO. —
PROJECT NO. 93-C028	NOZZLE (SIZE,#) —	CALIBRATION DATE 7-16-93	FILTER NO. —
TEST CREW D. Bian	STATIC PRESSURE —	PITOT CORRECTION —	STACK DIA. —
BAROMETRIC PRESSURE 28.38	PORT DIRECTION —	CONTROL BOX NO. Box 1 Portland	PORT SIZE —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Required (in. H2O)	Orifice ΔH Actual (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	~~Probe Temp.~~ Impinger Temp. (°F)	Impinger Temp. (°F)	Hot Box Temp. (°F)	Comments
—	1055	487.835	—	2.5	2.5	103	104	3.0	—	59	—	—	min./point
	1105	496.8		2.5	2.5	122	103	3.0		53			
	1115	504.2		2.5	2.5	122	106	3.0		53			
	1125	514.531		2.5	2.5	123	107	3.0		53			
													Estimates:
													MW=
													%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	15	0.001
After	15	0.001

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

GAS	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 6/92

KEYSTONE ENVIRONMENTAL RESOURCES, INC.
AIR QUALITY ENGINEERING

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[redacted] EPA METHOD 26 SOURCE SAMPLING DATA SHEET

CLIENT DOE
TEST UNIT ESP
PROJECT NO. Niles
SYSTEM OPERATOR Kent Rennie
BAROMETRIC PRESSURE

TEST DATE 7/30/93
TEST NO. N-4-NH9-731
SITE NO. Inlet 4
STACK DIAMETER
PORT DIRECTION

DRY GAS METER NO.
METER CORRECTION (Y)
CALIBRATION DATE

Traverse Point (inches)	Clock Time	Dry Gas Meter Reading (dcf)	Flow Rate ~~Back Reading~~ (ft³/min)	Rotameter Reading	Meter Exit Temp. (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Hot Box Temp. (°F)	Impinger Temp. (°F)	~~Probe~~ Temp. Heated line (°F)	~~Comments~~ Filter Inlet (°F)
	11:12	142.400			74/74		303	229	75/75	267	80
	11:14	143.635	.78	2.1	75/74	5	303	232	69/59	265	184
	11:17	146.764		2.1	77/74	5	303	244	67/58	264	196
	11:22	150.652	.775	2.1	77/74	5	303	249	67/57	264	201
11:27	End	154.311									
											Estimates:
											MW=
											%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (ft³/min)
Before	15	.015
After		

FYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO_2		
O_2		
CO		
N_2		

AQE 7/92

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE	TEST DATE 7-31-93 (Sat.)	ORIFICE CORRECTION 1.572	HOT BOX NO. 7
TEST UNIT Stack Hot Side	TEST NO. N-5a-NH-731	METER CORRECTION 1.0151	COLD BOX NO. 2
PROJECT NO. 93C628-01	NOZZLE (SIZE,#) 0.192	CALIBRATION DATE 7-2-93	PROBE NO. 5-3
CONTROL BOX OPERATOR JTB	STATIC PRESSURE -1.1 "H_2O	PITOT CORRECTION 0.84	FILTER NO. —
BAROMETRIC PRESSURE 29.06	PORT DIRECTION A	CONTROL BOX NO. 3	STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	1110	976.345	1.15	0.95	0.95	99	99	3.5	287	~250°F	68°F	~250°F	Single Point
	5		1.15	0.95	0.95	111	99	3.0	287				Isokinetic
	10		1.15	0.95	0.95	112	99	3.0	286				Sampling for
	15		1.15	0.95	0.95	114	99	3.0	286				30 min
	20		1.15	0.96	0.96	114	100	3.0	286				
	25		1.15	0.96	0.96	115	100	3.5	286				Readings every
	1140	993.189											5 min
	Δ=30 min	Δ=16.844 dcf	$(\Delta P)_{avg}$ = 1.15	$(\Delta H)_{avg}$ =	0.95	$(T_{meter})_{avg}$ = 105°F			$(T_{stack})_{avg}$ = 286°F				
									velocity = 71.9 ft/sec				
									ISO. = 95.9%				Estimates:
													MW= 29.5
													%H2O= 9

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	0.005
After	5.0	0.010

PITOT LEAK CHECK 15 sec

	Positive	Negative
Before	OK	OK
After	OK	OK

	1	2
CO2	14.5	
O2	6.0	
CO	0	
N2	79.5	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100 mL 0.1 N H_2SO_4	507.1	485.9	21.2
2.	100 mL 0.1 N H_2SO_4	568.5	561.9	6.6
3.	Empty	397.3	396.0	1.3
4.	Silica Gel	659.0	653.1	5.9
5.				

35.0 g total

Actual Moisture 9.6%

KEYSTONE

AQE 2/92

KEYSTONE
ENVIRONMENTAL RESOURCES, INC.

STACK SAMPLING DATA SHEET

PLANT: Niles, Ohio DATE: 7-31-93 ΔH@: 1.975 HOT BOX NO.: —
LOCATION: — TEST NO.: N-5B-NH₄-731 METER CORRECTION: .9921 COLD BOX NO.: —
ACTIVITY NO: 93C028 NOZZLE: — PITOT CORRECTION: — PROBE NO.: —
CONTROL BOX OPERATOR D. Bams STATIC PRESSURE Ps: — CONTROL BOX NO.: Box 1 Portable FILTER NO.: —
PROBE HANDLER — PORT DIRECTION: — NOMOGRAPH SET POINT: — STACK DIA.: —
CLEAN UP — BAROMETRIC PRESSURE 29.02 LENGTHS OF UMBILICAL — x 25' — x 50'

Point	Time	Meter Reading (dry) CF	Velocity HD In. H_2O	Orifice ΔH In. H_2O Req.	Act.	Meter Temp., T_m °F In	Out	Vacuum V_m In. Hg	Stack Temp. T_s °F	Probe Temp. T_p °F	Imp. Temp. T_I °C/°F	Hot Box Temp. T_H °F	Comments
—	1110	694.942	—	2.4	2.4	104	78	5	—	—	62	—	
	1120	702.6		2.4	2.4	117	98	5			45		
	1130	713.9		2.4	2.4	119	98	5			39		
	1140	723.248		2.4	2.4	120	99	5			38		

LEAK CHECK cfm

	In Hg	Rate
Before	15	0.000

ORSAT

	1	2	3
CO_2			
O_2			
CO			
N			

Impinger No.	Final	Initial	Difference
1			
2			
3			
4			
5			

D-5: Cyanide Train

N-4-CN-727

KEYSTONE ENVIRONMENTAL RESOURCES, INC.
AIR QUALITY ENGINEERING
[redacted] ~~EPA METHOD 26~~ SOURCE SAMPLING DATA SHEET

CLIENT DOE
TEST UNIT ESP
PROJECT NO. Niles
SYSTEM OPERATOR Kent Rennie
BAROMETRIC PRESSURE

TEST DATE 7/27/93
TEST NO. N-4-CY-727
SITE NO. Inlet 4
STACK DIAMETER
PORT DIRECTION

DRY GAS METER ID.
METER CORRECTION (Y)
CALIBRATION DATE

Traverse Point (inches)	Clock Time	Dry Gas Meter Reading (dcf)	Flow Rate ~~Back Reading~~ (ft³/min)	Rotameter Reading	Meter Exit Temp. (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Hot Box Temp. (°F)	Impinger Temp. (°F)	~~Probe~~ Temp. Heated Line (°F)	~~Comments~~ Filter Inlet °F
	14:10	951.600									
	14:12	~~[illegible]~~	.755	1.8	91/89	2.5	311	239	81/74	254	183
	14:15	955.535	.73	1.8	91/89	2.5	310	242	79/71	253	191
	14:20	959.225	.79	2.0	92/89	3.0	311	256	77/69	249	202
	14:30	966.776	.76	1.9	93/89	3.0	311	269	77/70	248	202
1437	~~14:27~~	972.317		1.9	93/90	3.5	311	262	78/71	247	209
	End	973.525									
											Estimates:
											MW=
											%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (ft³/min)
Before	15	.015
After		

Pitot tube Reading .84" H2O

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

FYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO2		
O2		
CO		
N2		

AQE 7/92

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT Stack - Hot Side
PROJECT NO. 93C628 01
CONTROL BOX OPERATOR JPS
BAROMETRIC PRESSURE 29.00

TEST DATE 07-27-93 (Tues)
TEST NO. N-5a-CN-727
NOZZLE (SIZE,#) 0.192
STATIC PRESSURE -1.0" H2O
PORT DIRECTION A

ORIFICE CORRECTION 1.572
METER CORRECTION 1.051
CALIBRATION DATE 7-2-93
PITOT CORRECTION 0.84
CONTROL BOX NO. 3

HOT BOX NO. 7
COLD BOX NO. 2
PROBE NO. 5-3
FILTER NO.
STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	1235	270.090	1.25	1.06	1.06	123	116	3.0	292	~250°F	<68°F	~250°F	Single Point
	1240		1.25	1.06	1.06	127	115	3.0	292				Isokinetic
	1245		1.25	1.06	1.06	129	115	3.0	292				Sampling for
	1250		1.25	1.06	1.06	130	115	3.0	292				1 HR
	1255		1.25	1.06	1.06	130	117	3.0	293				
	1300		1.20	1.02	1.02	131	117	3.0	293				Readings
	1305		1.20	1.02	1.02	131	117	3.0	293				every 5 min
	1310		1.20	1.02	1.02	131	117	3.0	293				
	1315		1.25	1.06	1.06	131	117	3.0	292				
	1320		1.25	1.06	1.06	132	118	3.0	293				
	1325		1.25	1.06	1.06	131	118	3.0	294				
	1330		1.25	1.06	1.06	132	118	3.0	294				
	1335	305.669											
													Estimates:
	Δ=60 min	Δ=35.579 dcf	(ΔP)avg = 1.25	(ΔH)avg = 1.05		(Tmeter)avg = 123°F			(Tstack)avg = 293°F				MW= 29.6
													%H2O= 9.0
								velocity = 75.3 ft/sec		Iso. = 94.6%			

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	0.010
After	5.0	0.006

PITOT LEAK CHECK 15 sec

	Positive	Negative
Before	OK	OK
After		

	1	2
CO2	15.0	
O2	6.0	
CO	0	
N2	79.0	

21% O2 on ambient air
1120

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100mL 0.1M NaOH	622.8	571.7	51.1
2.	100mL 0.1M NaOH	565.9	557.1	8.6
3.	~~[illegible]~~ Empty	450.3	449.3	1.0
4.	Silica Gel	668.3	659.0	9.3
5.				

Actual Moisture = 70.0 g total

AQE 2/92

KEYSTONE

STACK SAMPLING DATA SHEET

CLIENT Battelle DOE	TEST DATE 7-27-93	ORIFICE CORRECTION 1.775	HOT BOX NO. —
TEST UNIT 5B	TEST NO. N-5B-CN-727	METER CORRECTION 0.9921	COLD BOX NO. —
PROJECT NO. 93-C028	NOZZLE (SIZE,#) —	CALIBRATION DATE 7-16-93	PROBE NO.
CONTROL BOX OPERATOR D. Brown	STATIC PRESSURE —	PITOT CORRECTION —	FILTER NO. —
BAROMETRIC PRESSURE 28.41	PORT DIRECTION —	CONTROL BOX NO. Box 2 Portland	STACK DIA. —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
—	1235	305.057	—	2.0	2.0	118	112	3.0	—	—	64	—	
	1245	313.4		2.0	2.0	133	112	3.0			61		
	1255	321.4		2.0	2.0	135	113	3.0			54		
	1305	329.4		2.0	2.0	137	115	3.0			53		
	1315	338.0		2.0	2.0	137	115	3.0			53		
	1325	345.0		2.0	2.0	138	116	3.0			53		
	1335	353.8		2.0	2.0	138	116	3.0			53		
													Estimates:
													MW=
													%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	15	0.000
After	15	0.000

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

KEYSTONE

AQE 2/92

KEYSTONE ENVIRONMENTAL RESOURCES, INC.
AIR QUALITY ENGINEERING
[redacted] ~~EPA METHOD 26~~ SOURCE SAMPLING DATA SHEET

CLIENT DOE
TEST UNIT ESP
PROJECT NO. Niles
SYSTEM OPERATOR Kent Rennie
BAROMETRIC PRESSURE

TEST DATE 7/29/98
TEST NO. N-4-CN-729
SITE NO. Inlet 4
STACK DIAMETER
PORT DIRECTION

DRY GAS METER NO.
METER CORRECTION (Y)
CALIBRATION DATE

Traverse Point (inches)	Clock Time	Dry Gas Meter Reading (dcf)	Flow Rate ~~Buck~~ Reading (cc/min)	~~Rotameter~~ Reading Mano	Meter ~~Exit~~ Temp. I (°F) E	Vacuum (in. Hg)	Stack Temp. (°F)	Hot Box Temp. (°F)	~~Impinger~~ Temp. E (°F) I	~~Probe~~ Temp Heated line (°F)	~~Comments~~ Filter Inlet °F
	11:55	59.100			82/81		305	263	80/80	263	105
1157	~~11:52~~	60.621	.76	1.9	84/81	3	305	258	74/63	265	185
	12:00	62.905	.755	1.9	85/81	3	305	266	79/63	269	197
	12:10	70.398	.76	1.9	85/81	3	306	273	69/61	263	201
	12:25	82.279	.73		87/82	4	285	255	70/58	270	204
	End	83.095									
											Estimates:
											MW=
											%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (Afm/min)
Before	15	.03
After		

FYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 7/92

STACK SAMPLING DATA SHEET

CLIENT Battelle/DOE
TEST UNIT Stack - Hot Side
PROJECT NO. 93C628-01
CONTROL BOX OPERATOR JPS
BAROMETRIC PRESSURE 28.88

TEST DATE 7-29-93 (Thurs.)
TEST NO. N-SO-CN-729
NOZZLE (SIZE,#) 0.192
STATIC PRESSURE -14" H2O
PORT DIRECTION ⊥

ORIFICE CORRECTION 1.572
METER CORRECTION 1.0151
CALIBRATION DATE 7-1-93
PITOT CORRECTION 0.84
CONTROL BOX NO. 3

HOT BOX NO. 7
COLD BOX NO. 2
PROBE NO. 5-3
FILTER NO. —
STACK DIA. 132"

Traverse Point	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	11:40	630.530	1.20	1.01	1.01	114	107	2.5	289	~250°F	<68°F	~250°F	Single Point
	45		1.20	1.01	1.01	118	107	2.5	290				Isokinetic
	50		1.20	1.01	1.01	121	107	2.5	289				Sampling for
	55		1.15	0.97	0.97	121	108	2.5	289				1 hour
	00		1.15	0.97	0.97	122	107	2.5	289				
	05		1.15	0.97	0.97	122	108	2.5	289				Reading every
	10		1.15	0.97	0.97	122	108	2.5	289				5 minutes
	15		1.15	0.97	0.97	123	108	2.5	289				
	20		1.15	0.97	0.97	122	109	2.5	289				
	25		1.15	0.97	0.97	123	109	2.5	290				
	30		1.15	0.97	0.97	123	109	2.5	290				
	35		1.15	0.97	0.97	123	109	2.5	290				
	1240	665.672											
													Estimates:
	Δ=60 min	Δ=35.142 dcf	$(\Delta P)_{avg}$ = 1.15	$(\Delta H)_{avg}$ =	0.98	$(T_{meter})_{avg}$ = 115°F			$(T_{stack})_{avg}$ = 289°F				MW= 29.5 %H2O= 9

LEAK CHECK

	in. Hg	Rate (cfm)
Before	5.0	0.005
After	5.0	0.005

PITOT LEAK CHECK 15 sec

POS.	NEG.
OK	OK

	1	2
CO2	15.0	
O2	7.0	
CO	0	
N2	78.0	

velocity = 72.3 ft/sec
Iso. = 98.1%

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100 mL 0.1M NaOH	621.1	570.0	51.1
2.	100 mL 0.1M NaOH	566.5	557.9	8.6
3.	Empty	450.8	449.6	1.2
4.	Silica Gel	675.5	668.3	7.2
5.				

68.1 total
After
Moisture = 9.2

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

KEYSTONE ENVIRONMENTAL RESOURCES / AIR QUALITY ENGINEERING
STACK SAMPLING DATA SHEET

CLIENT Battelle DOE
TEST UNIT 5B
PROJECT NO. 93028
TEST CREW D. Brown
BAROMETRIC PRESSURE 28.88

TEST DATE 7-29-93
TEST NO. N-5B-CN-729
NOZZLE (SIZE,#) —
STATIC PRESSURE —
PORT DIRECTION —

ORIFICE CORRECTION (ΔH@) 1.975
METER CORRECTION (Y) 0.9921
CALIBRATION DATE 7-16-93
PITOT CORRECTION —
CONTROL BOX NO. Box 1 Portland

HOT/COLD BOX NO. —
PROBE NO. —
FILTER NO. —
STACK DIA. —
PORT SIZE —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Required (in. H20)	Orifice ΔH Actual (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°F)	Hot Box Temp. (°F)	Comments
—	1140	515.065	—	2.4	2.4	114	109	4.0	—	—	58	—	min./point
	1150	523.9		2.4	2.4	127	102	4.0			52		
	1200	533.1		2.4	2.4	130	108	4.0			52		
	1210	541.8		2.4	2.4	131	109	4.0			52		
	1220	551.0		2.4	2.4	131	110	4.0			52		
	1230	558.9		2.4	2.4	131	109	4.0			53		
	1240	568.391		2.4	2.4	131	109	4.0			52		
													Estimates:
													MW=
													%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	15	0.000
After	15	0.002

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

GAS	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 6/92

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

AIR QUALITY ENGINEERING

[redacted] EPA METHOD 26 SOURCE SAMPLING DATA SHEET

CLIENT DOE
TEST UNIT ESP
PROJECT NO. Niles
SYSTEM OPERATOR Kent Rennie
BAROMETRIC PRESSURE

TEST DATE 7/31/93
TEST NO. N-4-CN-731
SITE NO. Inlet 4
STACK DIAMETER
PORT DIRECTION

DRY GAS METER NO.
METER CORRECTION (Y)
CALIBRATION DATE

Traverse Point (inches)	Clock Time	Dry Gas Meter Reading (dcf)	Flow Rate ~~Buck Reading~~ (ft^3 ~~cc~~/min)	Rotameter Reading	Meter Exit Temp. (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Hot Box Temp. (°F)	Impinger Temp. (°F)	Probe Temp. (°F)	Comments
	11:51	154.808									
	11:53		.77	2.1	78/76	3	305	270	72/65	291	207
	11:56	158.791		2.1	79/76	3	305	266	68/61	290	216
	12:01	162.705	.77	2.0	79/86	3.5	305	262	69/58	286	216
	12:11	170.365	.76	2.0	80/77	4.0	305	261	69/59	279	216
	12:18	175.707		2.0	81/78	4.5	306	259	70/60	276	218
12:22	End	177.641									
											Estimates:
											MW=
											%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (ft^3 ~~cc~~/min)
Before	15	.01
After		

FYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO_2		
O_2		
CO		
N_2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 7/92

STACK SAMPLING DATA SHEET

CLIENT Battelle DOE
TEST UNIT Stack Hot Side
PROJECT NO. 93C0028-B1
CONTROL BOX OPERATOR JJS
BAROMETRIC PRESSURE 29.06

TEST DATE 7-31-93 (Sat.)
TEST NO. N-SC-CN-731
NOZZLE (SIZE,in) 0.192
STATIC PRESSURE -1.1" H2O
PORT DIRECTION A

ORIFICE CORRECTION 1.572
METER CORRECTION 1.0151
CALIBRATION DATE 7-2-93
PITOT CORRECTION 0.84
CONTROL BOX NO. 3

HOT BOX NO. 7
COLD BOX NO. 2
PROBE NO. 5-3
FILTER NO. —
STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	1200	993.683	1.15	0.95	0.95	108	101	4.5	288	~250°F	<68°F	~250°F	Single Point
	05		1.15	0.95	0.95	113	101	4.0	288				Isokinetic
	10		1.15	0.96	0.96	114	101	4.0	288				Sampling for
	15		1.15	0.96	0.96	115	101	4.0	288				1 hour -
	20		1.15	0.96	0.96	116	102	4.0	288				
	25		1.15	0.96	0.96	117	102	4.0	289				Readings every
	30		1.15	0.96	0.96	117	103	4.0	289				5 min
	35		1.15	0.96	0.96	118	103	4.0	289				
	40		1.15	0.96	0.96	117	103	4.0	289				
	45		1.15	0.96	0.96	118	103	4.0	289				
	50		1.15	0.96	0.96	118	104	4.0	290				
	55		1.15	0.96	0.96	118	104	4.0	290				
	1300	1027.550											
													Estimates:
	Δ=60 min	Δ=33.867 dcf	(ΔP)avg = 1.15	(ΔH)avg = 0.96		(Tmeter)avg = 109°F			(Tstack)avg = 289°F				MW= 29.5
								velocity = 72.1 ft/sec	ISO. = 95.8%				%H2O= 9

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	0.005
After	5.0	0.008

PITOT LEAK CHECK 15 sec

	Positive	Negative
Before	OK	OK
After	OK	OK

	1	2
CO2	14.0	
O2	6.5	
CO	0	
N2	79.5	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100 mL 0.1M NaOH	621.7	572.5	49.2
2.	100 mL 0.1M NaOH	566.8	558.8	8.0
3.	Empty	450.6	449.6	1.0
4.	Silica GEL	670.3	660.8	9.5
5.				

67.7 g total

Actual Moisture = 9.3%

KEYSTONE

AQE 2/92

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

STACK SAMPLING DATA SHEET

PLANT: Niles, Ohio
LOCATION: —
ACTIVITY NO: 93-C028
CONTROL BOX OPERATOR D. Bryan
PROBE HANDLER —
CLEAN UP —

DATE: 7-31-93
TEST NO.: N-5B-CN-731
NOZZLE: —
STATIC PRESSURE Ps: —
PORT DIRECTION: —
BAROMETRIC PRESSURE 29.02

$\Delta H@$: 1.975
METER CORRECTION: 0.9921
PITOT CORRECTION: —
CONTROL BOX NO.: Box 1 Portland
NOMOGRAPH SET POINT: —
LENGTHS OF UMBILICAL — x 25' — x 50'

HOT BOX NO.: —
COLD BOX NO.: —
PROBE NO.: —
FILTER NO.: —
STACK DIA.: —

Point	Time	Meter Reading (dry) CF	Velocity HD in. H_2O	Orifice ΔH in. H_2O Reg.	Orifice ΔH in. H_2O Act.	Meter Temp., T_m °F In	Meter Temp., T_m °F Out	Vacuum V_m in. Hg	Stack Temp. T_s °F	Probe Temp. T_p °F	Imp. Temp. T_I °C/°F	Hot Box Temp. T_H °F	Comments
—	1200	723.376	—	2.4	2.4	106	102	~~10~~ 7	—	—	49	—	
	1210	732.6		2.4	2.4	121	100	7			46		
	1220	740.4		2.4	2.4	122	101	7			41		
	1230	749.3		2.4	2.4	123	102	7			39		
	1240	758.2		2.4	2.4	122	102	7			39		
	1250	766.8		2.4	2.4	124	103	7			38		
	1300	775.911		2.4	2.4	124	103	7			38		

LEAK CHECK

	in Hg	Rate
Before	19	0.000
After	"	0.000

ORSAT

	1	2	3
CO_2			
O_2			
CO			
N			

Impinger No.	Final	Initial	Difference
1			
2			
3			
4			
5			

D-6: Aldehyde Trains

KEYSTONE ENVIRONMENTAL RESOURCES, INC.
AIR QUALITY ENGINEERING
[redacted] ~~EPA METHOD~~ SOURCE SAMPLING DATA SHEET

CLIENT DOE
TEST UNIT ESP
PROJECT NO. Niles
SYSTEM OPERATOR Kent Rennie
BAROMETRIC PRESSURE

TEST DATE 7/26/93
TEST NO. ~~Inlet 4~~ N-9-ALD-976
SITE NO. Inlet 4
STACK DIAMETER
PORT DIRECTION

DRY GAS METER NO.
METER CORRECTION (Y)
CALIBRATION DATE

Traverse Point (inches)	Clock Time	Dry Gas Meter Reading (dcf)	Flow Rate ~~Buck Reading~~ (lit/min)	Rotameter Reading	Meter Exit Temp. (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Hot Box Temp. (°F)	~~Impinger~~ Temp. Ice Bath °C	Probe Temp. (°F)	Comments
	17:30	706.20		.55		2	2	231	6		
	17:32	708.03	.60	.70		2		240	6		
	17:35	710.50	1.04	.95		2		257	6		
	18:02	735.91	.88	.95		2		255	5		
	18:15	748.75	.90	1.1		2		234	4		
	18:31	765.51	1.15	1.1		2		257	6		
	End	767.88									
											Estimates:
											MW=
											%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (liters/min)
Before	16	.02
After		

FYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 7/92

Page 1 of 1

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT Stack - Hot Side
PROJECT NO. 93C028-01
CONTROL BOX OPERATOR
BAROMETRIC PRESSURE 29.00

TEST DATE 7-26-93 (Mon.)
TEST NO. N-5a-ALD-726
NOZZLE (SIZE,#)
STATIC PRESSURE -1.0" H_2O
PORT DIRECTION A

ORIFICE CORRECTION —
METER CORRECTION 0.9735
CALIBRATION DATE 6-14-93
PITOT CORRECTION —
CONTROL BOX NO. DGM U586533

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. 5-3
FILTER NO. —
STACK DIA. [redacted] 132"

Traverse Point	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
40'2"	1720	0996.720		1000 cc/min	1064	97	97	0.0	302	~250°F	<68°F	~250°F	Single Point
	1725					97	97	0.0	303				Non-Isokinetic
	1730					97	97	0.0	303				Sampling for
	1735					97	97	0.0	303				1 hour at
	1740					97	97	0.0	303				1 L/min
	1745					97	97	0.0	303				
	1750					97	97	0.0	303				
	1755					97	97	0.0	303				
	1800					97	97	0.0	303				
	1805					97	97	0.0	304				
	1810					97	97	0.0	304				
	1815					97	97	0.0	304				
	1820	1056.710				98	98	0.0	304				
													Estimates:
						$(T_{meter})_{AVG}$ = 97°F			$(T_{stack})_{AVG}$ = 303°F				MW = 29.3
	Δ=60 min	Δ=59.990 dry liters											%H2O = 9

LEAK CHECK cc/min

	in. Hg	Rate ([redacted])
Before	4.0	12.5
After	3.0	5

	1	2
CO2	15.5	
O2	7.5	
CO	0	
N2	77.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	20mL DNPH	94.5	96.5	-2.0
2.	20mL DNPH	92.4	93.7	-1.3
3.	Empty	79.5	79.5	0.0
4.	Silica Gel	102.8	99.2	3.6
5.				

(0.3 g total)

PITOT LEAK CHECK

POS.	NEG.

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STACK SAMPLING DATA SHEET

CLIENT Battelle DOE
TEST UNIT ~~toB~~ Dilute SB
PROJECT NO. 93C028
CONTROL BOX OPERATOR D. Brown
BAROMETRIC PRESSURE 29.0

TEST DATE 7-26-93
TEST NO. ~~N-toB-AD-726-~~ VB
NOZZLE (SIZE,#) N-SB-ALD-726
STATIC PRESSURE —
PORT DIRECTION —

ORIFICE CORRECTION ~~1.66~~ 1.975
METER CORRECTION 0.9921
CALIBRATION DATE 7-16-93
PITOT CORRECTION —
CONTROL BOX NO. Box 1 Port

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. —
FILTER NO. —
STACK DIA. —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
									—	—	65	—	
—	1720	148.887	—	2.4	2.4	107	107	3.0					
	1736	157.3		2.4	2.4	126	107	3.0			61		
	1740	165.1		2.6	2.6	136	111	3.0			58		
	1750	175.7		2.6	2.6	137	114	3.5			49		
1800	~~1760~~	184.8		2.6	2.6	141	117	3.5			49		
	1810	194.1		2.6	2.6	142	117	3.5			47		
	1820	203.125		2.6	2.6	142	120	3.5			47		

Estimates:
MW=
%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	15	0.007
After	15	0.003

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

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KEYSTONE ENVIRONMENTAL RESOURCES, INC.
AIR QUALITY ENGINEERING
[redacted] ~~EPA METHOD~~ SOURCE SAMPLING DATA SHEET

CLIENT DOE
TEST UNIT ESP
PROJECT NO. Niles
SYSTEM OPERATOR Kent Rennie
BAROMETRIC PRESSURE

TEST DATE 7/28/93
TEST NO. N-4-ALD-728
SITE NO. Inlet 4
STACK DIAMETER
PORT DIRECTION

DRY GAS METER NO.
METER CORRECTION (Y)
CALIBRATION DATE

Traverse Point (inches)	Clock Time	Dry Gas Meter Reading (dcf)	Flow Rate ~~Reading~~ (lit/min)	Rotameter Reading	Meter Exit Temp. (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Hot Box Temp. (°F)	Impinger Temp. Ice Bath °C	Probe Temp. (°F)	Comments
	13:10	803.15	.70	.9		2		258/220	4		
	13:15	807.95	1.13	1.05		2		287/264	4		
	13:32	825.02	1.05	1.05		2		250/246	5		
	13:42	834.95	1.00	1.05		2		248/238	6		
	13:55	847.81	0.91	1.05		2		256/249	4		
End	14:15	867.29									
											Estimates:
											MW=
											%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (lit/min)
Before	16	.02
After		

FYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

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STACK SAMPLING DATA SHEET

CLIENT Battelle/DOE	TEST DATE 7-28-93 (Wed.)	ORIFICE CORRECTION —	HOT BOX NO. 1
TEST UNIT Stack - Hot Side	TEST NO. N-5a-AD-728	METER CORRECTION 0.9735	COLD BOX NO. 1
PROJECT NO. 93C028-01	NOZZLE (SIZE,#) Glass Tube	CALIBRATION DATE 6-14-93	PROBE NO. 5-3
CONTROL BOX OPERATOR MG	STATIC PRESSURE -1.2" H_2O	PITOT CORRECTION —	FILTER NO. —
BAROMETRIC PRESSURE 28.96	PORT DIRECTION A	CONTROL BOX NO. DGM U585535	STACK DIA. 132"

Traverse Point	Time	Dry Gas Meter Reading dry (liters)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	1450	639.545		1000 cc/min	1069	97	97	0.5	299	~250°F	68°F	250°F	Single Point
	55				1041	97	97	0.5	298				Non-Isokinetic
	00				1047	97	97	0.5	299		48		Sampling at
	05				1039	97	97	0.5	299				1 L/min
	10				1029	98	98	0.5	299		45		for 1 hour
	15				1026	98	98	0.5	299				
	20				1018	98	98	0.5	299		47		
	25				1036	99	99	0.5	299				
	30				985	99	99	0.5	299		48		
	35				981	99	99	0.5	299				
	40				1030	99	99	0.5	300		49		
	45				1036	99	99	0.5	300				
	1550	700.622			1033	99	99	0.5	300		49		
													Estimates:
	Δ=60 min	Δ=61.077 dry Liters				(Tmeter)Avg		=98°F	(Tstack)Avg	=	299°F		MW=29.5
													%H2O= 9

LEAK CHECK

	in. Hg	Rate (cc/min)
Before	4.0	13.5
After	4.0	18.1

	1	2
CO2	15.0	
O2	7.0	
CO	0	
N2	78.0	

O_2 Fyrite check = 20.5% at 1120

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	20mL DNPH	96.8	96.1	0.7
2.	20mL DNPH	94.4	94.4	0.0
3.	Empty	79.5	79.5	0.0
4.	Silica Gel	102.9	99.2	3.7
5.				

4.4 g total

Actual Moist 9.

PITOT LEAK CHECK

POS.	NEG.

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STACK SAMPLING DATA SHEET

CLIENT Battelle DOE
TEST UNIT 5B
PROJECT NO. 93C028
CONTROL BOX OPERATOR D. Brown
BAROMETRIC PRESSURE 28.96

TEST DATE 7-28-93
TEST NO. N-5B-ALD-728
NOZZLE (SIZE,#) —
STATIC PRESSURE —
PORT DIRECTION —

ORIFICE CORRECTION 1.975
METER CORRECTION 0.9921
CALIBRATION DATE 7-16-93
PITOT CORRECTION —
CONTROL BOX NO. Box 1 Portable 1

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. —
FILTER NO. —
STACK DIA. —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
—	1450	354.165	—	2.6	2.6	104	104	3.5	—	—	63	—	
	1500	363.2		2.6	2.6	124	105	4.0			56		
	1510	372.3		2.6	2.6	128	105	4.0			53		
	1520	381.1		2.6	2.6	137	113	4.0			54		
	1530	390.2		2.6	2.6	140	116	4.0			54		
	1540	400.7		2.6	2.6	141	119	4.0			54		
	1550	410.9		2.6	2.6	141	115	4.0			54		
	~~1600~~												
	~~1610~~												
	~~1620~~												
													Estimates:
													MW=
													%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	15	0.003
After	15	0.001

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

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[redacted] ~~EPA METHOD~~ SOURCE SAMPLING DATA SHEET

CLIENT DOE
TEST UNIT ESP
PROJECT NO. Niles
SYSTEM OPERATOR Kent Dennis
BAROMETRIC PRESSURE

TEST DATE 7/20/93
TEST NO. N-4-ALD-730
SITE NO. Inlet 4
STACK DIAMETER
PORT DIRECTION

DRY GAS METER NO.
METER CORRECTION (Y)
CALIBRATION DATE

Traverse Point (inches)	Clock Time	Dry Gas Meter Reading (dcf)	Elbow Rate ~~Buck Reading~~ (min)	Rotameter Reading	Meter Exit Temp. (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Hot Box Temp. (°F)	~~Impinger~~ Temp. Ice bath (°F)	Probe Temp. (°F)	Comments
	12:00	900.00		.7		2		170	0		
	12:20	923.35	.90	1.0		2		254	0		
32		937.10	.95	1.05		2		277	0		
		955.00	.87	1.00		2		263	0		
		963.88	.92	1.05		2		267	0		
											Estimates:
											MW=
											%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	[redacted] Rate ([redacted])
Before	17	[redacted]
After		

FYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO2	~~17~~	~~.0~~
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 7/92

90

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT Stack - Hot Side
PROJECT NO. 93C628-4
CONTROL BOX OPERATOR MG
BAROMETRIC PRESSURE 28.88

TEST DATE 7-30-93 (Fri.)
TEST NO. N-5a-ALD-730
NOZZLE (SIZE,#) —
STATIC PRESSURE -1.2" H_2O
PORT DIRECTION A

ORIFICE CORRECTION —
METER CORRECTION 0.9735
CALIBRATION DATE 6-14-93
PITOT CORRECTION —
CONTROL BOX NO. GM U58555

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. 5-3
FILTER NO. —
STACK DIA. 12"

Traverse Point (inches)	Time	Dry Gas Meter Reading Dry (L)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	1405	040.150			1056	76	76	0.5	289	~280°F	48°F	~280°F	Single Point
					1053	76	76	0.5	289				Sampling for
					1072	76	76	0.5	289	260	41	255	1 hour,
					1055	75	75	0.5	288				at 1 L/min
					1043	74	74	0.5	288	265	43	23 mins	
					1059	73	73	0.5	289			stopped	
					1047	72	72	0.5	289	265	45	255	
					1033	72	72	0.5	288				
					1032	72	72	0.5	289	262	42	257	
					1043	73	73	0.5	288				
					1027	75	75	0.5	288	265	47	260	
	1505	100.875			1028	75	75	0.5	289				
	Δ=60 min	Δ=60.725 dry Liters				$(T_{meter})_{Avg}$ = 74°F			$(T_{stack})_{Avg}$ = 289°F				Estimates: MW= 29.5 %H2O= 9

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate cc/min
Before	4.0	9.5
After	4.0	7.0

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	14.5	
O2	6.0	
CO	0	
N2	79.5	

1230 20.5% O_2 on

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	20 mL DNPH	96.9	96.7	0.2
2.	20 mL DNPH	95.0	94.5	0.5
3.	Empty	79.5	79.4	0.1
4.	Silica Gel	103.6	99.8	3.8
5.				

4.6 g total
Actual Moisture = 9.8%

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KEYSTONE ENVIRONMENTAL RESOURCES, INC.

1/1

STACK SAMPLING DATA SHEET

PLANT: Niles Ohio
LOCATION: —
ACTIVITY NO: 93(028
CONTROL BOX OPERATOR D. Brown
PROBE HANDLER —
CLEAN UP —

DATE: 7-30-97
TEST NO.: N-SB-ALD-730
NOZZLE: —
STATIC PRESSURE Ps: —
PORT DIRECTION: —
BAROMETRIC PRESSURE 28.93

ΔH@: 1.975
METER CORRECTION: 0.9921
PITOT CORRECTION: —
CONTROL BOX NO.: Box 1 Portland
NOMOGRAPH SET POINT: —
LENGTHS OF UMBILICAL — x 25' — x 50'

HOT BOX NO.: —
COLD BOX NO.: —
PROBE NO.: —
FILTER NO.: —
STACK DIA.: —

Point	Time	Meter Reading (dry) CF	Velocity HD In. H_2O	Orifice ΔH In. H_2O Req.	Orifice ΔH In. H_2O Act.	Meter Temp. T_m °F In	Meter Temp. T_m °F Out	Vacuum V_m In. Hg	Stack Temp. T_s °F	Probe Temp. T_p °F	Imp. Temp. T_I °C/°F	Hot Box Temp. T_H °F	Comments
—	1405	568.537	—	2.4	2.4	85	84	3.5	—	—	65	—	
	1415	577.4		2.4	2.4	105	85	3.5			64		
	1424	584.188									56		Shut down
											49		
	1427	584.188		2.4	2.4	106	88	3.5			60		Up
	1437	592.8		2.4	2.4	115	91	3.5			56		
	1447	601.6		2.4	2.4	118	93	3.5			54		
	1457	610.4		2.4	2.4	120	95	3.5			53		
	1507	619.6		2.4	2.4	120	96	3.5			52		
	1508	620.283		2.4	2.4	120	96	3.5			52		

LEAK CHECK CFM

	In Hg	Rate
Before	15	0.002
After	15	0.001

ORSAT

	1	2	3
CO_2			
O_2			
CO			
N			

Impinger No.	Final	Initial	Difference
1			
2			
3			
4			
5			

D-7: VOST Train

N-4 - VOS - 120 H 4 D

KEYSTONE ENVIRONMENTAL RESOURCES, INC.
AIR QUALITY ENGINEERING
[redacted] ~~EPA METHOD~~ SOURCE SAMPLING DATA SHEET

CLIENT DOE
TEST UNIT ESP
PROJECT NO. Niles
SYSTEM OPERATOR Kent Rennie
BAROMETRIC PRESSURE

TEST DATE 7/26/93
TEST NO. ~~Inlet 4~~ N-4-VOS-~~24~~926
SITE NO. Inlet 4
STACK DIAMETER
PORT DIRECTION

DRY GAS METER NO.
METER CORRECTION (Y)
CALIBRATION DATE

Traverse Point (inches)	Clock Time	Dry Gas Meter Reading (dcf)	Flow Rate ~~Buck Reading~~ (lit/min)	Rotameter Reading	Meter Exit Temp. (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Hot Box Temp. (°F)	~~Impinger~~ Temp. Condenser °C	~~Probe~~ Temp. Ice bath °C	~~Comments~~ Sample Names
⌀	14:40	672.92		.45		3			23	8	T001A
	14:42		.63	.8		3			21	5	TC023A
	14:44	674.90	.45	.5		3					
	14:46	675.88				3					
	End	676.11									
	15:10	676.21				3			21	7	T035A
	15:12		.55	.6		3					TC075A
	15:15	678.90	.51	.6		3			22	8	
	15:20	681.18	.48			3			20	6	
	End	682.58									
											Estimates:
											MW=
											%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (lit/min)
~~Before~~	16.5	.045
~~After~~	15	.01
	15	.01

5 min run
10 min run
30 min run

FYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO2		
O2		
CO		
N2		

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Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

N- 4- VOS - 726 C

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AIR QUALITY ENGINEERING
[redacted] ~~EPA METHOD~~ SOURCE SAMPLING DATA SHEET

Page of

CLIENT DoE
TEST UNIT ESP
PROJECT NO. Niles
SYSTEM OPERATOR Kent Renn
BAROMETRIC PRESSURE

TEST DATE 7/26/93
TEST NO. N-4- VOS - 726 C
SITE NO. Inlet 4
STACK DIAMETER
PORT DIRECTION

DRY GAS METER NO.
METER CORRECTION (Y)
CALIBRATION DATE

Traverse Point (inches)	Clock Time	Dry Gas Meter Reading (dcf)	Flow Rate ~~Back~~ Reading (lit/min)	Rotameter Reading	Meter Exit Temp. (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Hot Box Temp. (°F)	~~Impinger~~ Condenser Temp. °C	~~Probe~~ Ice Bath Temp. °C	Comments Sample Name
	15:50	682.79		.5		3			22	6	T083
	15:53		.40								TC044A
	15:55	685.59	.48	.6		3			20	7	
	16:00	688.36	.47	.6		3			20	4	
	16:32	705.14		.5		3.5			20	5	
	End	705.38									
											Estimates:
											MW=
											%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (lit/min)
Before	15	.01
After		

FYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 7/92

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE	TEST DATE 7-26-93 (Mon.)	ORIFICE CORRECTION —	HOT BOX NO. —
TEST UNIT Stack - Hot Side	TEST NO. N-5a - VOS - 726 - 1	METER CORRECTION 0.9735	COLD BOX NO. —
PROJECT NO. 93C028-01	NOZZLE (SIZE,#) —	CALIBRATION DATE 6-14-93	PROBE NO. 5-3
CONTROL BOX OPERATOR JPS	STATIC PRESSURE -1.0" H_2O	PITOT CORRECTION —	FILTER NO. —
BAROMETRIC PRESSURE 29.00	PORT DIRECTION D	CONTROL BOX NO. DGM U586555	STACK DIA. [redacted] 132"

Traverse Point	Time	Dry Gas Meter Reading Dry ([redacted] Liters	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	~~Impinger~~ Condensate Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
40'3"	1302	0241.005		500 cc/min		92		3.0		~250°F	<68°F	~250°F	VOST Tube #1
	1307	0243.690				92		2.0					5 min run
													at 0.5 L/min
	Δ=5	Δ=2.685				(Tmeter)Avg = 92°F							
	min	dry Liters											
											Tenax # T099		
											Tenax + Charcoal # TC013A		
													Estimates:
													MW=29.3
													%H2O=9

LEAK CHECK

	in. Hg	Rate ([redacted]) cc/min
Before	10.0	9.1
After	10.0	<10

← no bubble on Tuck

	1	2
CO2	15.5	
O2	7.5	
CO	0	
N2	77.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

PITOT LEAK CHECK

POS.	NEG.

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

page 1 of 1

STACK SAMPLING DATA SHEET

CLIENT	Battelle / DOE	TEST DATE	7-26-93 (Mon.)	ORIFICE CORRECTION	—	HOT BOX NO.	—
TEST UNIT	stack - hot side	TEST NO.	N-5a - V05 - 726 - 2	METER CORRECTION	0.9735	COLD BOX NO.	—
PROJECT NO.	93C028-01	NOZZLE (SIZE,#)	—	CALIBRATION DATE	6-14-93	PROBE NO.	5-3
CONTROL BOX OPERATOR	TPS	STATIC PRESSURE	-1.0" H_2O	PITOT CORRECTION	—	FILTER NO.	—
BAROMETRIC PRESSURE	29.00	PORT DIRECTION	D	CONTROL BOX NO.	DGM 4586535	STACK DIA.	[redacted] 132"

Traverse Point	Time	Dry Gas Meter Reading Dry ([redacted] Liters)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger condensate Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
	1355	0268.910		500 cc/min		93		2.5		~250°F	<68°F	~250°F	Lost Tube #
	1400					93		2.5					10 min run
													at 0.5 L/min
	1405	0273.328				93		2.5					
	Δ=10	Δ=4.418				(Tmeter)avg = 93°F							
	min	dry Liters											
											Tenax # T091		
											Tenax + Charcoal # TC049		
													Estimates:
													MW=29.3
													%H2O= 9

LEAK CHECK

	in. Hg	Rate (cc/min)
Before	10	8
After	10	8

	1	2
CO2	15.5	
O2	7.5	
CO	0	
N2	77.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

PITOT LEAK CHECK

POS.	NEG.

KEYSTONE

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT Stack - Hot Side
PROJECT NO. 93CØ28-Ø1
CONTROL BOX OPERATOR JTS
BAROMETRIC PRESSURE 29.00

TEST DATE 7-26-93 (Mon.)
TEST NO. N-5a-VOS-726-3
NOZZLE (SIZE,#) —
STATIC PRESSURE -1.0" H_2O
PORT DIRECTION D

ORIFICE CORRECTION —
METER CORRECTION 0.9735
CALIBRATION DATE 6-14-93
PITOT CORRECTION —
CONTROL BOX NO. DGM U5B6535

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. 5-3
FILTER NO. —
STACK DIA. [redacted] 132"

Traverse Point	Time	Dry Gas Meter Reading dry ([redacted] Liters)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	~~Impinger~~ Condensate Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
	1420	0277.200		500 cc/min		94		2.5		~250°F	<68°F	~250°F	VOST Tube #3
	1433					94		2.5					
	1438					94		2.5					30 min run
	1443					94		2.5					at 0.5 l/min
	1448					94		3.0					
	1453					94		5.0					
	1458	0291.148				94		5.0					
	Δ=30	Δ=13.948				$(T_{meter})_{Avg}$ = 94°F							
	min	dry Liters											
											Tenax # TØ81		
											Tenax & Charcoal #TCØ18A		
													Estimates:
													MW=29.3
													%H2O=9

LEAK CHECK

	in. Hg	Rate ([redacted]) cc/min
Before	10	8
After	10	10

PITOT LEAK CHECK

POS.	NEG.

	1	2
CO2	15.5	
O2	7.5	
CO	0	
N2	77.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

	Run 1	Run 2	Run 3
Tenax #	T004A	T048A	T046A
T/C #	TC054A	TC056A	TC002A

STACK SAMPLING DATA SHEET

CLIENT	BATTELLE/NILES	TEST DATE	7/26/93	ORIFICE CORRECTION	—	HOT BOX NO.	—
TEST UNIT	BOILER #2, 5B	TEST NO.	5B-VOS-726-1,2,3	METER CORRECTION	0.9993	COLD BOX NO.	—
PROJECT NO.	93002B	NOZZLE (SIZE,#)	—	CALIBRATION DATE	4/23/93	PROBE NO.	—
CONTROL BOX OPERATOR	MRP	STATIC PRESSURE	—	PITOT CORRECTION		FILTER NO.	—
BAROMETRIC PRESSURE	29.00	PORT DIRECTION	Dilution Sampler	CONTROL BOX NO.	Nutech #6, 50030	STACK DIA.	

Traverse Point (inches)	Time Clk/min	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
—	1301,0	6850.27	—	1.1	1.1	99	99	3	—	—	—	—	pre leak: 4 cc/min @ 3
—	1306,5	6852.83	—	1.1	1.1	100	103	3	—	—	—	—	post leak: 4 cc/min @ 3
—	1355 0	6856.08	—	1.0	1.0	103	103	4	—	—	—	—	pre leak: 6 cc/min @ 4
—	5	858.40	—	1.0	1.0	102	106	4	—	—	—	—	
—	10	860.58	—			102	106	4	—	—	—	—	post leak: 12 cc/min @ 4
—	1428 0	6862.02	—	1.0	1.0	105	105	3	—	—	—	—	pre leak: 6 cc/min @ 5
—	5	64.35	—	1.0	1.0	102	107	3	—	—	—	—	
—	10	67.21	—	1.0	1.0	103	107	3	—	—	—	—	
—	15	70.10	—	1.0	1.0	103	107	3	—	—	—	—	
—	20	72.50	—	1.0	1.0	103	107	3	—	—	—	—	
—	25	74.5	—	1.0	1.0	103	107	3	—	—	—	—	
—	30	6877.03	—			103	107	[illegible]	—	—	—	—	post leak: 5 cc/min @ 6
													Estimates:
													MW=
													%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

KEYSTONE

AQE 2/92

N-4-VOS-728 A, B, C

KEYSTONE ENVIRONMENTAL RESOURCES, INC.
AIR QUALITY ENGINEERING

[redacted] ~~EPA METHOD~~ SOURCE SAMPLING DATA SHEET

CLIENT DOE
TEST UNIT ESP
PROJECT NO. Niles
SYSTEM OPERATOR Kent Rennie
BAROMETRIC PRESSURE

TEST DATE 7/28/93
TEST NO. ~~[illegible]~~ N-4-VOS-728
SITE NO. Inlet 4
STACK DIAMETER
PORT DIRECTION

DRY GAS METER NO.
METER CORRECTION (Y)
CALIBRATION DATE

Traverse Point (inches)	Clock Time	Dry Gas Meter Reading (dcf)	Flow Rate ~~Stack Reading~~ (Lit ~~cc~~/min)	Rotameter Reading	Meter Exit Temp. (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	~~Hot Box~~ Temp. Ice Bath (°F)	~~Impinger~~ Temp. Condenser (°F)	Probe Temp. (°F)	~~Comments~~ Sample Names
		~~[illegible]~~									T077
N-4-VOS-728A	10:25	772.10	.65	.55		3		4	18		TC014A
	10:30	774.40	.48	.45		3		5	17		
	End	775.22									
N-4-VOS-728B	10:40	775.46	.55	.45		2		3	20		T089
	10:45	777.87	.53	.45		2		3	15		TC035A
	10:51	780.50	.54	"		2		3	19		
	End	781.38									
											T088
N-4-VOS-728C	11:05	781.58	.40	.4		~~4~~ 2		4	17		~~TC~~ TC024A
	11:23	789.65	.47	.45		2		5	18		Estimates:
	11:35	794.66	.51	.45		3		6	21		MW=
End	11:41	797.23									%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (Lit ~~cc~~/min)	
Before	15	.02	5 min run
After	16	.01	10 min run
	17	.01	20 min "

FYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 7/92

Page 1 of 1

STACK SAMPLING DATA SHEET

CLIENT Battelle/DOE	TEST DATE 7-28-93 (Wed)	ORIFICE CORRECTION —	HOT BOX NO. —
TEST UNIT Stack-Hot Side	TEST NO. N-5a-VOS-728-1	METER CORRECTION 0.9735	COLD BOX NO. —
PROJECT NO. 93C028-01	NOZZLE (SIZE,#) —	CALIBRATION DATE 6-14-93	PROBE NO. 5-3
CONTROL BOX OPERATOR JPS	STATIC PRESSURE -1.0" H_2O	PITOT CORRECTION —	FILTER NO. —
BAROMETRIC PRESSURE 28.96	PORT DIRECTION D	CONTROL BOX NO. [illegible] 36535	STACK DIA. 132"

Traverse Point	Time	Dry Gas Meter Reading Dry Liters	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	~~Impinger~~ Condensate Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
	0915	0068.200		500 cc/min		88		2.5		~250°F	<68°F	~260°F	VOST Tube #1
	0920	0070.568				88		3.0			39°F		5 min run at
													0.5 L/min
	Δ=5	Δ=2.368				$(T_{meter})_{AVG}$ = 88°F							
	min	dry Liters											
											Tenax #T097		
											Tenax + Charcoal #TC052A		
													Estimates:
													MW= 29.[illegible]5
													%H2O= 9

LEAK CHECK

	in. Hg	Rate (cc/min)
Before	10.0	4.0
After	10.0	5.0

	1	2
CO_2	15.0	
O_2	7.0	
CO	0	
N_2	78.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

PITOT LEAK CHECK

POS.	NEG.

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

Page 1 of 1

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE	TEST DATE 7-28-93 (Wed.)	ORIFICE CORRECTION —	HOT BOX NO. —
TEST UNIT Stack - Hot Side	TEST NO. N-5a-VOS-728-2	METER CORRECTION 0.9735	COLD BOX NO. —
PROJECT NO. 93C028-01	NOZZLE (SIZE,#) —	CALIBRATION DATE 6-14-93	PROBE NO. 5-3
CONTROL BOX OPERATOR JPX	STATIC PRESSURE -1.0" H_2O	PITOT CORRECTION —	FILTER NO. —
BAROMETRIC PRESSURE 28.96	PORT DIRECTION D	CONTROL BOX NO. DGM US86555	STACK DIA. 132"

Traverse Point	Time	Dry Gas Meter Reading Dry (Liters)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	~~Impinger~~ Condensate Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
	0946	0094.152		500 cc/min		88		3.0		~250°F	<68°F	~250°F	VOST Tube #2
	0951					89		7.0			40		10 min run
													at 0.5 L/min
	0956	0099.011				90		6.0					
	Δ=10	Δ=4.859				(Tmeter)Avg	= 89°F						
	min	dry Liters											
											Tenax # T094		
											Tenax + Charcoal	# TC060A	
													Estimates:
													MW= 29.5
													%H2O= 9

LEAK CHECK

	in. Hg	Rate (cc/min)
Before	10	7.0
After	10	9.0

	1	2
CO_2	15.0	
O_2	7.0	
CO	0	
N_2	78.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

PITOT LEAK CHECK

POS.	NEG.

KEYSTONE

Page 1 of 1

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE	TEST DATE 7-28-93 (Wed.)	ORIFICE CORRECTION —	HOT BOX NO. —
TEST UNIT Stack - Hot Side	TEST NO. N-5a - VOS- 728-3	METER CORRECTION 0.9735	COLD BOX NO. —
PROJECT NO. 93C028-41	NOZZLE (SIZE,#) —	CALIBRATION DATE 6-14-93	PROBE NO. 5-3
CONTROL BOX OPERATOR JPS	STATIC PRESSURE -1.0" H_2O	PITOT CORRECTION —	FILTER NO. —
BAROMETRIC PRESSURE 28.96	PORT DIRECTION ↻	CONTROL BOX NO. DGM 4586535	STACK DIA. 132"

Traverse Point	Time	Dry Gas Meter Reading Dry (Liters)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	~~Impinger~~ Condensate Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
	1107	0107.849		500cc/min		91		3.0		~250°F	<68°F	~250°F	lost Tube #3
	1112					91		3.0			42		30 min run
													at 0.5 L/min
	1117					91		3.0			38		
	1122					91		3.0			38		
	1127					91		3.0			39		
	1132					92		3.0			39		
	1137	0122.714				92		3.0			Tenax #T079		
											Tenax + Charcoal #TC0531		
													Estimates: TC053A
	Δ=30	Δ=14.865				(Tmeter) avg = 91°F							MW=29.5
	min	dry Liters											%H2O= 9

LEAK CHECK

	in. Hg	Rate (cc/min)
Before	10	5.0
After	10	8.0

	1	2
CO2	15.0	
O2	7.0	
CO	0	
N2	78.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

PITOT LEAK CHECK

POS.	NEG.

KEYSTONE

CARTRIDGE	RUN 1	RUN 2	RUN 3
TENAX	T076	T078	T082
TENAX/CHARCOAL	TC004A	TC064	TC050

STACK SAMPLING DATA SHEET

Page 1 of 1

CLIENT ~~EB~~ BATTELLE
TEST UNIT BOILER #2 SB NILES
PROJECT NO. 93C028
CONTROL BOX OPERATOR MCP
BAROMETRIC PRESSURE 28.96

TEST DATE 7/28/93
TEST NO. N-SB-VOS-728-1,2,3
NOZZLE (SIZE,#) —
STATIC PRESSURE —
PORT DIRECTION A

ORIFICE CORRECTION —
METER CORRECTION 0.9993
CALIBRATION DATE 4/23/93
PITOT CORRECTION —
CONTROL BOX NO. Nutech #6, 500304

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. —
FILTER NO. —
STACK DIA.

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
													LEAK CHECKS
Run 1	0915	6878.83	—	—	1.0	98	98	3	—	—	Iced	—	pre: 8 cc/min @ 4" Hg
	0920	6880.13	—	—	1.0	96	101	3	—	—	|	—	post: 13.3 cc/min @ 4"
Run 2	0950	6880.42	—	—	1.0	97	97	3	—	—	Iced	—	pre: 8 cc/min @ 3" Hg
	1000	83.2	—	—	1.0	98	100	3	—	—	|	—	
	1005	85.6	—	—	1.0	99	101	3	—	—		—	post: 7.3 cc/min @ 3" Hg
		Run 2 interrupted @ t=3:20 due to sheared pin											
Run 3	1105	6886.54	—	—	1.0 ~~101~~	101	101	3	—	—	Iced	—	pre: 3 cc/min @ 3" Hg
	1110	889.12	—	—	1.0	100	103	3	—	—			
	1115	891.7	—	—	1.0	101	105	3	—	—			
	1120	893.9	—	—	1.0	101	106	3	—	—			
	1125	~~898.6~~	—	—	1.0	101	106	3	—	—			
	1130	~~900.1~~	—	—	1.0	101	106	3	—	—			post:
	1135	900.1	—	—	1.0	102	106	3	—	—			Estimates:
													MW=
													%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

KEYSTONE

AQE 2/92

KEYSTONE ENVIRONMENTAL RESOURCES, INC.
AIR QUALITY ENGINEERING

[redacted] ~~EPA METHOD~~ SOURCE SAMPLING DATA SHEET

CLIENT DOE
TEST UNIT ESP
PROJECT NO. Niles
SYSTEM OPERATOR Kent Penn...
BAROMETRIC PRESSURE

TEST DATE 7/30/93
TEST NO. N-4-VOS-730AB
SITE NO. Inlet
STACK DIAMETER
PORT DIRECTION

DRY GAS METER NO.
METER CORRECTION (Y)
CALIBRATION DATE

Traverse Point (inches)	Clock Time	Dry Gas Meter Reading lit ~~(dcf)~~	Flow Rate ~~Delta Reading~~ (lit/min)	Rotameter Reading	Meter Exit Temp. (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	~~Hot Box~~ Temp. Ice Bath (°F)	~~Impinger~~ Temp. Condenser (°F)	Probe Temp. (°F)	~~Comments~~ Sample Names
	9:40	869.95	.50	.6		3.5		4	15		T080
	9:45	873.11		.6		3.5		4	14		TC003A
	10:00	873.47	.51	.6		3.0		4	14		T104
	10:05	876.44	.70	.6		3.0		4	14		TC027A
	10:10	879.17	.59	.5		2.0		5	13		
	10:30	879.90	.61	.5		2.0		4	12		T085
	10:35	882.58	.51	.45		2.0		4	12		TC052A
	10:40	884.71	.42	.45		2.0		5	12		
	10:50	889.16	.50	.49		2.0		5	12		
	11:02	895.850	.59	.47		3.0		7	13		Estimates:
	End	897.04									MW=
											%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (lit/min)	
Before	15	.01	5 min
After	17	.03	10 " "
	17	.02	30 " "

FYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO_2		
O_2		
CO		
N_2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 7/92

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT Stack - Hot Side
PROJECT NO. 93 Ø28-01
CONTROL BOX OPERATOR JB
BAROMETRIC PRESSURE 28.88

TEST DATE 7-30-93 (Fri)
TEST NO. N-5a - VOS - 730 - 1
NOZZLE (SIZE,#) —
STATIC PRESSURE -1.2" H_2O
PORT DIRECTION D

ORIFICE CORRECTION —
METER CORRECTION 0.9735
CALIBRATION DATE 6-14-93
PITOT CORRECTION —
CONTROL BOX NO. DGMU586555

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. 5-3
FILTER NO. —
STACK DIA. 132"

Traverse Point	Time	Dry Gas Meter Reading Dry ([illegible] Liters)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	~~Impinger~~ condensate Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
	0926	0263.386		500 cc/min	–	76		3.0		~250°F	<68°F	~250°F	VOST Tube #1
	0931	0266.002				76		3.0			36°F		5 min run at
													0.5 L/min
	Δ=5	Δ=2.616				(Tacks)AVG = 76°F							
	min	dry Liters											
											Tenax # TØ87		
											Tenax + Charcoal # TCØ76		
													Estimates:
													MW=29.5
													%H2O= 9

LEAK CHECK cc/min

	in. Hg	Rate ([illegible])
Before	10	3.0
After	10	6.0

CHECK

[illegible] REQ.

	1	2
CO2	14.5	
O2	6.0	
CO	0	
N2	79.5	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

KEYSTONE

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STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE	TEST DATE 7-30-93 (Fri.)	ORIFICE CORRECTION —	HOT BOX NO. —
TEST UNIT Stack - Hot Side	TEST NO. N-5a-V05-730-2	METER CORRECTION 0.9735	COLD BOX NO. —
PROJECT NO. 93C028-01	NOZZLE (SIZE,#) —	CALIBRATION DATE 6-14-93	PROBE NO. 5-3
CONTROL BOX OPERATOR JPS	STATIC PRESSURE -1.2" H2O	PITOT CORRECTION —	FILTER NO. —
BAROMETRIC PRESSURE 28.88	PORT DIRECTION D	CONTROL BOX NO. DGM U5B6535	STACK DIA. 132"

Traverse Point	Time	Dry Gas Meter Reading Dry (~~cu.ft.~~) Liters	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	~~Impinger~~ Condensate Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
	1000	1202.352		500 cc/min		77		3.0		~250°F	<68°F	~250°F	Nost Tube #2
	1005					77		3.0			38		10 min run at
													0.5 L/min
	1010	1207.439				77		3.0					
	Δ=10	Δ=5.087				(Tmeter)Avg = 77°F							
	min	dry Liters											
											Tenax #T092		
											Tenax & charcoal #TC033/		
													Estimates:
													MW= 29.5
													%H2O= 9

LEAK CHECK

	in. Hg	Rate (cc/min)
Before	10	5.0
After	10	5.0

	1	2
CO2	14.5	
O2	6.0	
CO	0	
N2	79.5	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

PITOT LEAK CHECK

POS.	NEG.

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE	TEST DATE 7-30-93 (Fri.)	ORIFICE CORRECTION —	HOT BOX NO. —
TEST UNIT Stack - Hot Side	TEST NO. N-5a - VOS - TSO - 3	METER CORRECTION 0.9735	COLD BOX NO. —
PROJECT NO. 93CP28-01	NOZZLE (SIZE,#) —	CALIBRATION DATE 6-4-93	PROBE NO. 5-3
CONTROL BOX OPERATOR JB	STATIC PRESSURE -1.2" H_2O	PITOT CORRECTION —	FILTER NO. —
BAROMETRIC PRESSURE 28.88	PORT DIRECTION D	CONTROL BOX NO. DGM USBL535	STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading Dry Liters	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	~~Impinger~~ Condensate Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
	1045	1212.739		500 cc/min		76		3.0		~250°F	<68°F	~250°F	Vost Tube #3
	1050					76		3.0			40°F		
	1055					76		3.0			41°F		30 min at
	1100					76		3.0			42°F		0.5 L/min
	1105					76		3.0			48°F		
	1110					76		3.0			43°F		
	1115	1227.372				76		3.0					
	Δ=30	Δ=14.633				$(T_{meter})_{avg}$ = 76°F							
	min	dry liters											
											Tenax # T086		
											Tenax + charcoal #TC015A		
													Estimates:
													MW= 29.5
													%H2O= 9

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate cc/min
Before	10	4.0
After	10	7.0

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	14.5	
O2	6.0	
CO	0	
N2	79.5	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 2/92

KEYSTONE

TENAX | T102 | T098 | T100
TENAX/CHARCOAL | TC05BA | TC012 | TC02BA

KEYSTONE ENVIRONMENTAL RESOURCES / AIR QUALITY ENGINEERING
STACK SAMPLING DATA SHEET

CLIENT BATTELLE
TEST UNIT BOILER #2, LOC 5B
PROJECT NO. 93C028
TEST CREW MRP
BAROMETRIC PRESSURE 28.93

TEST DATE 7/30/93
TEST NO. N-5B-V05-730-1,2,3
NOZZLE (SIZE,#) —
STATIC PRESSURE —
PORT DIRECTION A

ORIFICE CORRECTION (ΔH@) —
METER CORRECTION (Y) 0.9993
CALIBRATION DATE 4/23/93
PITOT CORRECTION —
CONTROL BOX NO. NUTECH #6, 500804

HOT/COLD BOX NO. —
PROBE NO. —
FILTER NO. —
STACK DIA. —
PORT SIZE —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Required (in. H20)	Orifice ΔH Actual (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°F)	Hot Box Temp. (°F)	Comments LEAK ✓
Run 1	0928	6903.35	—	—	1.0	85	85	3.0	—	—	iced	—	min./point
.	0934	6905.96	—	—	1.0	83	86	3.0	—	—	-"-	—	pre: 7 cc/min @ 5" Hg
													post: 13 cc/min @ 3" Hg
Run 2	0958	6906.72	—	—	1.0	85	85	3.5	—	—	iced	—	pre: 9 cc/min @ 4" Hg
.	1003	6908.33	—	—	1.0	84	88	3.5	—	—	-"-	—	
.	1008	6910.61	—	—	1.0	84	81	3.5	—	—	-"-	—	post: 8 cc/min @ 3.5" Hg
Run 3	1045	6910.79	—	—	1.0	84	84	3.5	—	—	iced	—	pre: 4 cc/min @ 3.5" Hg
.	1050	—			1.0	84	85						
.	1055	6915.93				84	87						
.	1100	—				84	88						
.	1105	6920.37				84	89						
.	1110	6922.53				84	89						
.	1115	6924.93				84	89						post: 4 cc/min @ 3.5" Hg
													Estimates:
													MW=
													%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		
GAS	1	2
CO2		
O2		
CO		
N2		

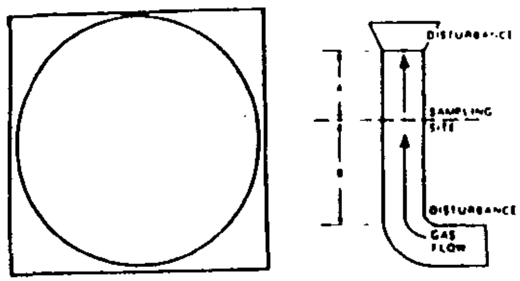
Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 6/92

D-8: HEST Samples

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

PLANT Miles Ohio
DATE 7/27/93
LOCATION ESP inlet
OPERATOR Leonard
STACK NO.
RUN NO. N-4-HES-727
SAMPLE BOX NO.
METER BOX NO. X-40513-8

AMBIENT TEMPERATURE 89°F
BAROMETRIC PRESSURE 28.82
ASSUMED MOISTURE, %
PROBE LENGTH, in. S.S.
NOZZLE DIAMETER, in. 0.180
STACK DIAMETER, in. 140
PROBE HEATER SETTING 250°F
HEATER BOX SETTING 250°F

METER $\Delta H_@$
C FACTOR
PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
	TOTAL	

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{\Delta P_s}$)		PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	~~VELOCITY~~ Probe
	0/							~~320.090~~						
	0/15:14							321.401						
	15/15:56	power off						333.237						
	15/17:18	power on	310					333.237	90	89	245	60	18.0	
	42/17:45		310					353.4	91	89	249	79	21.0	
	57/18:00		309					364.7	88	88	245	78	21.0	238
	72/18:15		309					375.3	88	88	247	78	21.0	248
	102/18:45		310					396.0	89	88	252	74	21.0	256
	117/19:00		310					406.0	87	87	250	72	21.5	256
	132/19:15		311					415.9	88	87	251	74	21.5	256
	147/19:30		310					425.3	87	87	252	74	21.5	266
	162/19:45		309					434.5	87	86	252	70	21.7	257
	180/20:00	off						448.630						
								321.401						
								127.229						
TOTAL														
AVERAGE														

leak check 0.040 at 23" Hg

COMMENTS

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

STACK SAMPLING DATA SHEET

CLIENT Battelle/DOE	TEST DATE 07-27-93 (Tues.)	ORIFICE CORRECTION 1.802	HOT BOX NO. 2
TEST UNIT Stack - Hot Side	TEST NO. N-5a-H-727	METER CORRECTION 0.9619	COLD BOX NO. 2
PROJECT NO. 93C028-01	NOZZLE (SIZE,#) 0.188	CALIBRATION DATE 05-17-93	PROBE NO. 5-1
CONTROL BOX OPERATOR TM	STATIC PRESSURE -1.0" H_2O	PITOT CORRECTION 0.84	FILTER NO. Test #E
BAROMETRIC PRESSURE 29.00	PORT DIRECTION Port "B"	CONTROL BOX NO. SGUG	STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
19.3	12:45	790.408		0.90	0.90	100	95	21.0	296	~250°F	<68°F	~260°F	Single Point
				0.90	0.90	102	96	21.0	296				Non-isokinetic
				0.90	0.90	106	97	21.0	296				Sampling for
				0.90	0.90	108	98	21.0	296				4 hours
				0.90	0.90	110	98	21.0	297				Target ΔH = 1.4" H_2O
				0.90	0.90	110	98	21.0	297				
	13:45			0.90	0.90	112	102	21.0	298				Readings
				0.90	0.90	112	102	21.0	298				every 10 min.
				0.95	0.95	112	104	21.0	298				
				0.95	0.95	112	104	20.5	299				
				0.95	0.95	116	106	20.5	300			Filter	#93-Q2736
				0.95	0.95	116	106	20.5	300				#93-M264
	14:45			1.00	1.00	116	106	20.5	300				#93-M265
				1.00	1.00	116	106	20.5	300				
				1.00	1.00	116	106	20.5	299				Estimates:
				1.00	1.00	116	106	20.5	299				MW= 29.6
				1.00	1.00	116	106	20.5	299				%H2O= 9.0
				1.05	1.05	116	106	20.5	300				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	10.0	5.02
After	21.0	<0.02

PITOT LEAK CHECK 15 sec

	Positive	Negative
Before	ok	ok
After	ok	ok
	1	2

CO2	15.0	
O2	6.0	
CO	0	
N2	79.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100 mL DI H_2O	686.5	547.4	139.1
2.	100 mL DI H_2O	516.2	483.9	32.3
3.	Empty	452.7	435.7	17.0
4.	Silica Gel	694.0	654.3	39.7
5.				

228.1 total

Actual Moisture = 6.8

KEYSTONE

AQE 2/92

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE	TEST DATE 7-27-93 (Tues)	ORIFICE CORRECTION 1.602	HOT BOX NO. 2
TEST UNIT Stack - Hot Side	TEST NO. N-5a-H-~~L~~ 727	METER CORRECTION 0.9613	COLD BOX NO. 2
PROJECT NO. 93C028-01	NOZZLE (SIZE,#) 0.188	CALIBRATION DATE 5.17.93	PROBE NO. 5-1
CONTROL BOX OPERATOR TM	STATIC PRESSURE -1.0" H2O	PITOT CORRECTION 0.84	FILTER NO. Test #E
BAROMETRIC PRESSURE 29.00	PORT DIRECTION Port B	CONTROL BOX NO. 7	STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
.	15:45			1.05	1.05	116	106	20.5	300	~258°F	48°F	~250°F	Single Port
				1.05	1.05	116	106	20.5	300				NonIsokinetic
				1.05	1.05	116	106	20.0	300				Sampling for
				1.10	1.10	116	106	20.0	301				4 hours
				1.10	1.10	116	106	20.0	301				
				1.10	1.10	116	106	20.0	301				Target
	16:45	928.800											ΔH=1.40
													Readings every
	Δ=240	Δ=138.392		$(\Delta H)_{AVG}$	=0.98	$(T_{meter})_{AVG}$	= 108°F		$(T_{stack})_{AVG}$	= 299°F			10 min
	min	dcf											
											Filter # 93-Q2736		
												#93-M264	
												#93-M265	
													Estimates:
													MW=29.6
													%H2O=9

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	15.0	
O2	6.0	
CO	0	
N2	79.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

KEYSTONE

AQE 2/92

Middle 93-M263
BTM 93-M262

HEST FILTER #3 : ~~TOP (Quartz)~~ – ~~93-Q2736~~
~~MIDDLE (carbon)~~ – ~~93-M264~~
~~BOTTOM (carbon)~~ – ~~93-M265~~ MRP

STACK SAMPLING DATA SHEET

CLIENT Battelle	TEST DATE 7/27/93	ORIFICE CORRECTION 2.002	HOT BOX NO. —
TEST UNIT 5B	TEST NO. NJ5B-H-727	METER CORRECTION 0.9812	COLD BOX NO. —
PROJECT NO. 93C028	NOZZLE (SIZE,#) —	CALIBRATION DATE 6-9-93	PROBE NO. —
CONTROL BOX OPERATOR MRP	STATIC PRESSURE —	PITOT CORRECTION —	FILTER NO. —
BAROMETRIC PRESSURE 28.94	PORT DIRECTION —	CONTROL BOX NO. Box 26 Pitt	STACK DIA.

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
—	1245 0	623.475	—	—	2.05	99	99	16	—	—	iced	—	
	10		—	—	2.1	115	101	16	—	—		—	
	20	~~639.645~~			2.1	125	107	16					
	30	648.6			2.1	122	109	16					
	40	657.2			2.1	129	112	16					
	50	667.4			2.1	132	113	16					
	1315 60	674.3			2.1	133	~~133~~ 115	16					
	70	683.4			2.1	134	119	16					
	80	691.2			2.1	135	119	16					
	90	700.4			2.1	135	119	16					
	100	708.3			2.1	135	119	16					
	110	717.1			2.1	135	119	16					
	1445 120	725.6			2.1	137	121	16					
	130	734.0			2.1	137	121	16					
	140	742.4			2.1	138	122	16					Estimates:
	150	751.2			2.1	139	122	16					MW=
	160	760.1				139	122	16			✓		%H2O=
	170	769.16			2.1	139	123	16					

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	15	0.003
After	17	0.001

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

KEYSTONE

AQE 2/92

STACK SAMPLING DATA SHEET

CLIENT Battelle
TEST UNIT 5B
PROJECT NO. 930028
CONTROL BOX OPERATOR MRP
BAROMETRIC PRESSURE 28.94

TEST DATE 7-23-93
TEST NO. N-5B-H-727
NOZZLE (SIZE,#) —
STATIC PRESSURE —
PORT DIRECTION —

ORIFICE CORRECTION 2.002
METER CORRECTION 0.9812
CALIBRATION DATE 6-9-93
PITOT CORRECTION —
CONTROL BOX NO. Box 6 Pittsburgh

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. —
FILTER NO. —
STACK DIA. —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
—	1545	777.3	—	2.1	2.1	139	123	16	—	—	Iced	—	
	1555	785.2		2.1	2.1	139	123	16					
	1605	793.4		2.1	2.1	139	123	16					
	1615	801.6		2.1	2.1	139	123	16					
	1625	810.0		2.1	2.1	139	124	16					
	1635	818.6		2.1	2.1	139	124	16					
	1645	826.261		2.1	2.1	139	124	16					

Estimates:
MW=
%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

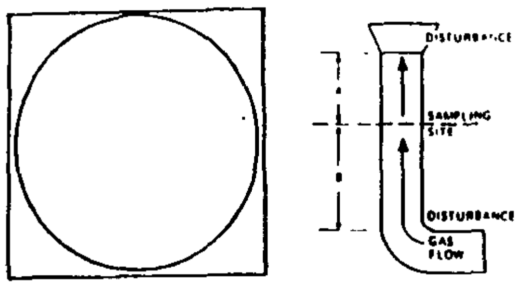
	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

KEYSTONE

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

PLANT Niles, Ohio, Ohio 'iron
DATE 7/29/93
LOCATION ESP inlet
OPERATOR Leonard
STACK NO.
RUN NO. N-4-HES-789
SAMPLE BOX NO.
METER BOX NO. X-40513-B

AMBIENT TEMPERATURE 78°F
BAROMETRIC PRESSURE 28.75
ASSUMED MOISTURE, % 7
PROBE LENGTH, in. S.S.
NOZZLE DIAMETER, in. 0.180
STACK DIAMETER, in. 140"
PROBE HEATER SETTING 250°F
HEATER BOX SETTING 250°F

METER ΔH@ 1.60
C FACTOR
PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
	TOTAL	

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	probe temp, °F ~~STATIC PRESSURE (in. H_2O)~~	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY fps
42" in/	0/13:10	243	299			1.85	1	452.148	79	79	249	62	21.0	
stack	15/13:25	268	299			1.60		462.7	79	78	251	70	21.0	
	30/13:40	273	300			1.50		474.	80	79	248	73	21.0	
	45/13:55	262	300			1.40		484.3	80	80	250	72	21.0	
	60/14:10	249	300			1.30		494.1	81	80	242	73	21.0	
	75/14:25	244	301			1.30		504.1	82	82	252	74	21.5	
	90/14:40	254	300			1.20		514.0	81	81	253	63	21.5	
	105/14:55	260	302			1.10		523.1	84	83	255	65	21.5	
	120/15:10	262	300			1.10		532.5	81	81	253	62	21.5	
	135/15:25	261	301			1.00		541.2	81	81	255	64	21.5	
	150/15:40	265	301			0.95		550.0	84	83	255	66	21.5	
	165/15:55	269	301			0.90		558.7	82	82	256	66	22.0	
	180/16:10	271	300			0.85		566.5	81	81	254	67	22.0	
	220/16:50	off						587.144						
								~~452.148~~						
TOTAL								134.996						
AVERAGE														

leak check after 0.08 cfm at 24" Hg

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS filter leaks before start 0.075 cfm at 23" Hg

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT Stack Hot Side
PROJECT NO. 93C028-01
CONTROL BOX OPERATOR TW
BAROMETRIC PRESSURE 28.88

TEST DATE 02-24-93 (Thur.)
TEST NO. N-56-H-729
NOZZLE (SIZE,#) 0.188
STATIC PRESSURE -1.1" H2O
PORT DIRECTION Port B

ORIFICE CORRECTION 1.802
METER CORRECTION 0.9619
CALIBRATION DATE 05-17-93
PITOT CORRECTION 0.84
CONTROL BOX NO. Seven

HOT BOX NO. #1
COLD BOX NO. #1
PROBE NO. C-1
FILTER NO. Bypass Heat # E
STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
9.1	11:40	930.622		0.80	0.80	96	90	18.0	293	~250°F	68°F		Single Point
				0.80	0.80	100	90	18.0	293				Non Isokinetic
				0.80	0.80	102	90	18.0	297				4 hrs total
				0.80	0.80	108	92	18.0	294				10 min readings
				0.85	0.85	109	92	18.0	294				Target ΔH
				0.85	0.85	110	94	18.0	294				1.40" H2O
	12:40			0.85	0.85	110	94	18.0	294				
				0.85	0.85	110	94	18.0	294				
				0.85	0.85	110	94	18.0	295				
				0.70	0.90	111	96	18.0	295			Filter #	93Q2735
				0.90	0.90	112	96	18.0	294				# 93-M285
				0.90	0.90	112	96	18.0	295				# 93-M286
	13:40			0.90	0.90	112	96	18.0	295				
				0.90	0.90	112	97	18.0	295				
				0.95	0.95	112	97	18.0	296				Estimates:
				0.95	0.95	112	97	18.0	296				MW= 29.1
				0.95	0.95	112	98	18.0	295				%H2O= 9.0
				0.95	0.95	112	98	18.0	295				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	10.0	<.003
After	20.0	0.002

PITOT LEAK CHECK 15 sec

	Positive	Negative
Before	ok	ok
After	ok	ok

	1	2
CO2	15.0	
O2	7.0	
CO	0	
N2	78.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100mL DI H2O	719.8	549.4	170.4
2.	100mL DI H2O	478.0	463.4	14.6
3.	Empty	442.7	436.1	6.6
4.	Silica Gel	692.0	649.6	42.4
5.				

234.0 cc total

Actual Moisture: 13.2%

KEYSTONE

AQE 2/92

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE
TEST UNIT STACK HOT-SIDE
PROJECT NO. 93C028-01
CONTROL BOX OPERATOR TM
BAROMETRIC PRESSURE 28.88

TEST DATE 07-29-93 (THUS.)
TEST NO. N-5G-H-729
NOZZLE (SIZE,#) 0.188
STATIC PRESSURE -1.1" H2O
PORT DIRECTION PORT B

ORIFICE CORRECTION 1.802
METER CORRECTION 0.9619
CALIBRATION DATE 03-17-93
PITOT CORRECTION 0.84
CONTROL BOX NO. SEVEN

HOT BOX NO. #1
COLD BOX NO. #1
PROBE NO. 5-1
FILTER NO. BYPASS Test #1
STACK DIA. 13.2'

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H20)	Orifice ΔH Act. (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
	14:40			0.95	0.95	112	98	18.0	295	~250°F	<68°F Imp.		SINGLE POINT
				0.95	0.95	112	98	18.0	295				NON ISOKINETIC
Stopped	1300	995.110		1.00	1.00	112	98	18.0	296			Stopped	4 HRS TOTAL
Start	1305	997.210		1.05	1.05	114	98	20.0	296		Oxygen meter stopped		10 MINS READING
				1.05	1.05	118	98	20.0	296				Major ΔH = 1.4" H2O
				1.10	1.10	118	98	20.0	295				
	15:40			1.10	1.10	118	98	20.0	295				
	15:45	1016.283										Filter #	93-Q2735
													# 93-M285
	Δ=240 min	Δ=83.561 dcf		(ΔH)avg = 0.92		(Tmeter)avg = 103°F			(Tstack)avg = 295°F				# 93-M286
											Need to check DGM		
													Estimates:
													MW= 29.1
													%H2O= 9.0

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	15.0	
O2	7.0	
CO	0	
N2	78.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

KEYSTONE

AQE 2/92

MIDDLE : 93 - M267
BTM : 93 - M266

KEYSTONE ENVIRONMENTAL RESOURCES / AIR QUALITY ENGINEERING
STACK SAMPLING DATA SHEET

CLIENT Battelle	TEST DATE 7-29-93	ORIFICE CORRECTION ($\Delta H@$) 2.002	HOT/COLD BOX NO. —
TEST UNIT 5B	TEST NO. N-5B-H-729	METER CORRECTION (Y) 0.9812	PROBE NO. —
PROJECT NO. 931028	NOZZLE (SIZE,#) —	CALIBRATION DATE 6-9-93	FILTER NO. —
TEST CREW D. Brown	STATIC PRESSURE —	PITOT CORRECTION —	STACK DIA. —
BAROMETRIC PRESSURE 28.88	PORT DIRECTION —	CONTROL BOX NO. Box 6 Maurice	PORT SIZE —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Required (in. H2O)	Orifice ΔH Actual (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°F)	Hot Box Temp. (°F)	Comments
—	1140	827.025	—	2.4	2.4	94	94	16	—	—	Iced	—	min./point
	1150	836.4		2.4	2.4	106	97	16					
	1200	844.6		2.4	2.4	113	99	16					
	1210	854.1		2.4	2.4	117	102	16					
	1220	863.4		2.4	2.4	121	104	16					
	1230	872.3		2.4	2.4	122	105	16					
	1240	881.2		2.4	2.4	124	107	16					
	1250	889.3		2.4	2.4	124	109	16					
	1300	899.3		2.4	2.4	125	109	16					
	1310	908.4		2.4	2.4	125	110	16					
	1320	917.4		2.4	2.4	125	110	16					
	1330	925.1		2.4	2.4	125	110	16					
	1340	935.7		2.4	2.4	125	110	16					
	1350	944.1		2.4	2.4	125	110	16					
	1400	953.4		2.4	2.4	125	110	16					
	1410	962.3		2.4	2.4	125	110	16					Estimates:
	1420	961.3		2.4	2.4	125	110	16					MW=
	1430	979.1		2.4	2.4	125	110	16					%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	15	0.000
After	17	0.001

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

GAS	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 6/92

KEYSTONE ENVIRONMENTAL RESOURCES / AIR QUALITY ENGINEERING
STACK SAMPLING DATA SHEET

CLIENT	Battelle DOE	TEST DATE	7-29-93	ORIFICE CORRECTION (ΔH@)	2.002
TEST UNIT	SB	TEST NO.	N-SB-H-729	METER CORRECTION (Y)	0.9812
PROJECT NO.	93-6028	NOZZLE (SIZE,#)	—	CALIBRATION DATE	6-9-93
TEST CREW	D. Brown	STATIC PRESSURE	—	PITOT CORRECTION	—
BAROMETRIC PRESSURE	28.88	PORT DIRECTION	—	CONTROL BOX NO.	Box 6 Monroe

HOT/COLD BOX NO.	—
PROBE NO.	—
FILTER NO.	—
STACK DIA.	—
PORT SIZE	—

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Required (in. H20)	Orifice ΔH Actual (in. H20)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°F)	Hot Box Temp. (°F)	Comments
	1440	988.8		2.4	2.4	127	111	15			Ice		min./point
	1450	997.3		2.4	2.4	127	111	15					
	1500	006.5		2.4	2.4	127	111	15					
	1510	015.6		2.4	2.4	127	111	15					
	1520	024.9		2.4	2.4	127	111	15					
	1530	033.6		2.4	2.4	127	111	15					
	1540	043.145		2.4	2.4	127	111	15					
													Estimates:
													MW=
													%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

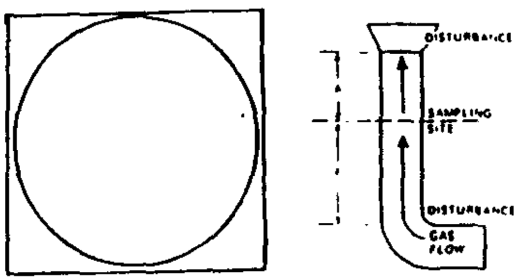
GAS	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 6/92

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

PLANT Miles Ohio Ohio Edison
DATE 7/31/93
LOCATION E SP inlet
OPERATOR Leonard
STACK NO. ______
RUN NO. N-4-HES-731
SAMPLE BOX NO. ______
METER BOX NO. X-40513-8

AMBIENT TEMPERATURE ______
BAROMETRIC PRESSURE 28.93
ASSUMED MOISTURE, % 7
PROBE LENGTH, in. ______
NOZZLE DIAMETER, in. 0.180
STACK DIAMETER, in. 140"
PROBE HEATER SETTING 250°F
HEATER BOX SETTING 250°F

METER $\Delta H_@$ 1.6
C FACTOR ______
PROCESS WEIGHT RATE ______

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	probe Temp of ~~STATIC PRESSURE (in. H₂O)~~	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY fps
	0/12:50					1.80		582.924					19.5	
	20/13:10	267	302			1.60		601.1	84	83	254	67	21.0	
	35/13:25	267	302			1.40		~~612.8~~	83	83	257	69	21.0	
	50/13:40	270	299			1.30		622.8	83	83	256	68	21.3	
	55/13:45	off sheared arm												
	57/13:52	on						632.						
	65/14:02							632.8						
	80/14:17	273	301			1.20		642.3	84	83	255	69	21.5	
	95/14:32	273	301			1.10		651.5	84	84	258	72	21.7	
	110/14:47							660.8						
	125/15:02	271	304			0.97		669.1	86	86	258	71	21.8	
	140/15:17	271	302			0.92		677.7	87	86	256	70	21.8	
	155/15:32	271	306			0.87		686.0	88	87	259	74	22.0	
	/15:30							718.257						
							—	587.924						
TOTAL								130.333						
AVERAGE														

heated lines 152+153°F leak check before 0.061
hex filter leaks

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS
nozzle is 22" from the top of stack. 22" inside of stack measured from the top
140" ID of stack minus 22" = 118" from the bottom

STACK SAMPLING DATA SHEET

CLIENT BATTELLE / DOE
TEST UNIT STACK HOT-SIDE
PROJECT NO. 93C028-01
CONTROL BOX OPERATOR TM
BAROMETRIC PRESSURE 29.06

TEST DATE 07-31-93 (Sat.)
TEST NO. N-5G-M-731
NOZZLE (SIZE,#) 0.188
STATIC PRESSURE -1.1" H_2O
PORT DIRECTION PORT B

ORIFICE CORRECTION 1.802
METER CORRECTION 0.9619
CALIBRATION DATE 05-17-93
PITOT CORRECTION 0.84
CONTROL BOX NO. SEVEN

HOT BOX NO. #2
COLD BOX NO. #2
PROBE NO. 5-1
FILTER NO. BYPASS HEST
STACK DIA. 132" #E

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
39.1	8:00	820.700		1.30	1.30	93	92	17.0	285	~250°F	<68°F [illegible]	280°F	SINGLE POINT
				1.40	1.40	93	92	17.0	285				NON ISOKINETIC
				1.45	1.45	93	91	17.0	285				10 MIN READING
				1.45	1.45	93	91	17.0	285				4 HRS TOTAL
				1.45	1.45	94	98	17.0	285				TARGET ΔH
				1.45	1.45	94	92	17.0	285				1.4" H_2O
	9:00			1.45	1.45	94	92	17.0	285				
				1.45	1.45	94	93	17.0	285				
				1.50	1.50	95	93	16.5	285				Plant [illegible]
				1.50	1.50	95	93	16.5	285			1:45	Stopped Testing
				1.40	1.40	96	93	16.0	285			1:53	Start Testing
				1.40	1.40	96	93	16.0	285				
	14:00			1.40	1.40	96	93	16.0	285		Filter	# 93	-Q2733
				1.40	1.40	97	95	15.5	285			#93	-M287
				1.40	1.40	97	95	15.5	285			#93-M28[illegible]	Estimates:
				1.40	1.40	97	95	15.5	285				MW= 29.5
				1.40	1.40	97	95	15.5	285				%H2O= 9.0
				1.40	1.40	98	95	15.5	285				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	10.0	<.02
After	12.0	0.011

PITOT LEAK CHECK 15 sec

	Positive	Negative
Before	ok	ok
After	ok	ok

	1	2
CO2	14.0	
O2	6.5	
CO	0	
N2	79.5	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100 mL DI H_2O	663.0	549.2	113.8
2.	100 mL DI H_2O	486.9	469.9	17.0
3.	Empty	443.1	435.9	7.2
4.	Silica Gel	699.0	659.5	39.5
5.				

177.5 g total

Actual Moisture = 5.3%

KEYSTONE

AQE 2/92

STACK SAMPLING DATA SHEET

CLIENT Battelle Labs
TEST UNIT Stack Hot Side
PROJECT NO. 93C028-01
CONTROL BOX OPERATOR TM
BAROMETRIC PRESSURE 29.06

TEST DATE 07-31-93 (Sat.)
TEST NO. N-59-H-731
NOZZLE (SIZE,#) 0.188
STATIC PRESSURE -1.1"H_2O
PORT DIRECTION Port

ORIFICE CORRECTION 1.802
METER CORRECTION 0.9619
CALIBRATION DATE 05-17-93
PITOT CORRECTION 0.84
CONTROL BOX NO. SGUG

HOT BOX NO. #2
COLD BOX NO. #2
PROBE NO. 5-1
FILTER NO. Bypass Hot
STACK DIA. 132"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
	15:00			1.40	1.40	98	96	15.0	285	~250°F	68°F [illegible]	~250°F	Single Point
				1.40	1.40	98	96	15.0	285				Non Isokinetic
				1.40	1.40	98	96	15.0	285				10 min/Reading
				1.40	1.40	99	96	14.5	285				4 hrs Total
				1.40	1.40	99	96	14.5	285				Target ΔH
				1.40	1.40	99	97	14.5	285				1.4" H_2O
	16:00			1.40	1.40	99	97	14.5	285				
	16:08	988.470											
												Filter #	93Q2733
												#	93-M287
	Δ =	Δ = 167.7[illegible]		$(\Delta H)_{avg}$ =	1.42	$(T_{meter})_{avg}$ = 95°F		$(T_{stack})_{avg}$ = 285°F				#	93-M288
	240	dcf											
	min												

Estimates:
MW = 29.5
%H2O = 9.0

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	14.0	
O2	6.5	
CO	0	
N2	79.5	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

KEYSTONE

AQE 2/92

2/2

Chester Environmental Dilution Sampling Data Sheet
Battelle/DOE—Coal Creek

Date	
Location	
Run Number	N-5B-726
Operator	
Ambient Temperature	
Barometric Pressure (in. Hg)	

Pitot Coeff.	
Meter Box ΔH@	
Nozzle Diameter (in.)	
Dilution Ratio	
Static Pressure (in. H_2O)	

Filter IDs:

8×10		
HEST		
Impactor	1	5
	2	6
	3	7
	4	8

Clock Time	Sampling Time	Amb. Temp. (°F)	Stack Temp. (°F)	Probe Temp. (°F)	Static Press. (in. H_2O)	Vel. Press. (in. H_2O)	Chamber Press. (in. H_2O)	Chamber Temp (°F)	Orifice Vacuum (in. H_2O)	Orifice Press. Drop (in. H_2O)	Meter Box ΔH (in. H_2O)	Meter Box Temp. (°F)	Meter Box Vac. (in. Hg)	Meter Box Meter Reading	Diluant Temp. (°F)	Diluant Press. (psig)
1530	270	95	288	300	-1.0	1.1	2.67	112	-11	.44	1.55	125	5	164.0	100	16
1545	285	98	289	301	-1.0	1.1	2.67	112	-11	.44	1.55	125	5	179.4	100	16
1600	300	98	286	304	-1.0	1.1	2.67	113	-11	.44	1.56	125	5	195.0	100	16
1615	315	98	287	302	-1.0	1.1	2.67	113	-11	.44	1.56	125	5	208.2	102	16
1630	330	97	289	305	-1.0	1.1	2.67	113	-11	.44	1.56	125	5	219.1	102	16
1645	345	97	291	307	-1.0	1.1	2.67	113	-11	.44	1.56	125	5	228.4	101	16
1700	360	97	296	304	-1.0	1.1	2.67	113	-11	.44	1.56	125	5	238.6	102	16
1715	375	96	295	306	-1.0	1.1	2.67	112	-11	.44	1.56	125	5	244.1	101	16
1730	390	96	292	307	-1.0	1.1	2.67	113	-11	.44	1.56	125	5	256.1	101	16
1745	405	95	296	309	-1.0	1.1	2.67	113	-11	.44	1.56	127	5	265.8	102	16
1800	420	95	294	307	-1.0	1.1	2.67	113	-11	.44	1.56	127	5	276.9	102	16
1815	435	95	293	309	-1.0	1.1	2.67	112	-11	.44	1.56	125	5	288.4	101	16
1830	450	95	291	307	-1.0	1.1	2.67	112	-11	.44	1.56	125	5	301.0	101	16
1845	465	95	290	306	-1.0	1.1	2.67	113	-11	.44	1.56	125	5	311.4	100	16
1900	480	95	290	301	-1.0	1.1	2.67	113	-11	.44	1.56	125	5	322.6	100	16
														607		

93C028.F02 9 (see also 181025-2.F02)

Revised 06/16/93

Dilution Sampler Field Data
Stack Description and Parameters

Coal Creek Run No. N-58-~~7~~27 Date 7-27-93

Use defaults as required for presampling setup. Operator JWM

Box 5
CAL 5-17-93
Y_{PACRON}: 0.9832

Obtain by	Parameter	Value	Unit	Nomen.	Default
Calibration:	Probe Coeff. A	6.3425	—	A_p	See probe calibration summary
	Probe Coeff. B	1.8168	—	B_p	
	Probe Cal. Temp.	68	°F	$T_{cal.p}$	68
	Probe Cal. Press.	29.92	in. Hg	$P_{cal.p}$	29.92
	Orifice Coeff. A	0.0018	—	A_o	0.0018
	Orifice Coeff. B	1.9897	—	B_o	1.9897
	Orifice Cal. Temp.	68	°F	$T_{cal.o}$	68
	Orifice Cal. Press.	29.92	in. Hg	$P_{cal.o}$	29.92
	Meter Box ΔH@	1.734	in. H_2O	ΔH@	1.7
	Pitot Coeff.	0.84	—	C_p	0.84
Measure:	Ambient Temp.	88	°F	T_a	90
	Barometer	28.94	in. Hg	P_b	29.92
	Stack Temp.	287	°F	T_s	220
	Static Press.	1.0	in. H_2O	P_s	−1.5
	Velocity Press.	1.1	in. H_2O	VP	1.8
	Stack Moist.	9	% vol	H_2O	17.3
	Chamber Temp.	160	°F	T_C	90
	Orifice Vacuum	−11	in. H_2O	V_o	−15
	Meter Box Temp.	~~105~~ 110	°F	T_{dgm}	100
Specification:	Dilution Ratio	30	—	DR	30
	Nozzle Diameter	.178	in.	d	0.178
	Impactor Rate	.75	acfm	Q_i	0.75
Calculation:	Stack Velocity	4245	ft/min	V_s	
	Probe Flow	0.7336	acfm	$Q_{act.}$	
	Probe Flow	0.5003	scfm	$Q_{std.}$	
	Chamber Press.	2.6688	in. H_2O	P_C	
	Orifice Flow	16.73	acfm	Q_{oa}	
	Orifice Flow	14.83	scfm	Q_{os}	
	Orifice Press. Drop	0.4294	in. H_2O	P_O	
	Meter Box ΔH	1.57	in. H_2O	ΔH	

93C028.F01 (see also 92C042.F01, 181025-2.F01)
Revised 06/16/93

PSDS LEAK RATE : 0.045
DATE : 7-25-93

CHESTER ENVIRONMENTAL

VAC 5" Hg

INITIAL TARGETS
P_c = 2.67
P_o = .43
ΔH = 1.57

Chester Environmental Dilution Sampling Data Sheet
Battelle/DOE—Coal Creek

% H_2O = 9.2, MW_d = 30.64

1/2

Date	7-27-93
Location	SB
Run Number	N-SB-727
Operator	Jum
Ambient Temperature	85
Barometric Pressure (in. Hg)	28.94

Pitot Coeff.	0.84
Meter Box ΔH@	1.731
Nozzle Diameter (in.)	0.178
Dilution Ratio	30
Static Pressure (in. H_2O)	-1

Filter IDs:

8x10	N-SB-MUM-727		
HEST			
Impactor	1	5	
	2	6	
	3	7	
	4	8	

PURGE @ 745

Clock Time	Sampling Time	Amb. Temp. (°F)	Stack Temp. (°F)	Probe Temp. (°F)	Static Press. (in. H_2O)	Vel. Press. (in. H_2O)	Chamber Press. (in. H_2O)	Chamber Temp (°F)	Orifice Vacuum (in. H_2O)	Orifice Press. Drop (in. H_2O)	Meter Box 322.905 ΔH (in. H_2O)	Meter Box Temp. (°F)	Meter Box Vac. (in. Hg)	Meter Box Meter Reading	Diluent Temp. (°F)	Diluent Press. (psig)
0815	0	88	287	312	-1.0	1.1	2.67	100	-11	0.43	1.57	110	4.5	~~[illegible]~~	95	16.5
830	15	88	286	314	-1.0	1.1	2.67	101	-11	0.43	1.57	112	4.5	334.7	93	16.5
845	30	89	289	317	-1.0	1.1	2.67	103	-11	0.43	1.57	115	4.5	346.0	94	16.5
900	45	89	286	321	-1.0	1.1	2.67	104	-11	0.43	1.57	115	4.5	356.9	94	16.5
915	60	88	287	324	-1.0	1.1	2.67	104	-11	0.43	1.56	115	4.5	369.0	94	16.5
930	75	89	285	326	-1.0	1.1	2.67	104	-11	0.43	1.56	115	4.5	380.7	94	16.5
945	90	89	286	324	-1.0	1.1	2.67	104	-11	0.43	1.56	115	4.5	392.3	94	16.5
1000	105	89	287	327	-1.0	1.1	2.67	104	-11	0.43	1.56	116	4.5	404.9	94	16.5
1015	120	88	288	329	-1.0	1.1	2.67	105	-11	0.43	1.56	116	4.5	415.9	94	16.5
1030	135	88	287	326	-1.0	1.1	2.67	105	-11	0.43	1.56	116	4.5	428.4	94	16.5
1045	150	88	286	325	-1.0	1.1	2.67	105	-11	0.43	1.56	116	4.5	438.3	94	16.5
1100	165	88	288	321	-1.0	1.1	2.67	103	-11	0.43	1.56	116	4.5	451.0	94	16.5
1115	180	88	286	324	-1.0	1.1	2.67	104	-11	0.43	1.56	116	4.5	463.1	94	16.5
1130	195	89	287	324	-1.0	1.1	2.67	104	-11	0.43	1.56	116	4.5	475.0	94	16.5
1145	210	88	290	325	-1.0	1.1	2.67	104	-11	0.43	1.56	116	4.5	486.1	94	16.5
1200	225	89	290	326	-1.0	1.1	2.67	104	-11	0.43	1.56	116	4.5	497.2	94	16.5
1215	240	89	290	325	-1.0	1.1	2.67	104	-11	0.43	1.56	116	4.5	508.9	95	16.5
1230	255	90	289	324	-1.0	1.1	2.67	104	-11	0.43	1.56	116	4.5	520.4	95	16.5

93C028.F02 9 (see also 181025-2.F02)

Revised 06/16/93

IMPACTOR LEAK CHECK: PRE-TEST 0.005 / 10" (RATE + VAC)
POST-TEST 0.007 / 10"

7/2

Chester Environmental Dilution Sampling Data Sheet
Battelle/DOE—Coal Creek

Date	7-27-93
Location	SB
Run Number	N-SB-727
Operator	
Ambient Temperature	
Barometric Pressure (in. Hg)	

Pitot Coeff.	
Meter Box ΔH@	
Nozzle Diameter (in.)	
Dilution Ratio	
Static Pressure (in. H_2O)	

Filter IDs:

8×10		
HEST		
Impactor	1	5
	2	6
	3	7
	4	8

DISCONNECTED IMPACTOR @ 5 HRS

							Chamber		Orifice		Meter Box				Diluant	
Clock Time	Sampling Time	Amb. Temp. (°F)	Stack Temp. (°F)	Probe Temp. (°F)	Static Press. (in. H_2O)	Vel. Press. (in. H_2O)	Press. (in. H_2O)	Temp (°F)	Vacuum (in. H_2O)	Press. Drop (in. H_2O)	ΔH (in. H_2O)	Temp. (°F)	Vac. (in. Hg)	Meter Reading	Temp. (°F)	Press. (psig)
1245	270	90	287	326	-1.0	1.1	2.67	105	-11	0.43	1.56	116	4.5	532.9	95	16.5
1300	285	90	289	321	-1.0	1.1	2.67	105	-11	0.43	1.56	114	4.5	544.3	95	16.5
1315	300	91	292	324	-1.0	1.1	2.67	105	-11	0.43	1.56	118	4.5	557.0	95	16.5
1330	315	91	291	326	-1.0	1.1	2.67	105	-11	0.43	1.56	118	4.5	567.8	95	16.5
1345	330	91	289	324	-1.0	1.1	2.67	105	-11	0.47	1.56	118	4.5	578.3	96	16.5
1400	345	90	287	321	-1.0	1.1	2.67	105	-11	0.43	1.56	119	4.5	591.6	95	16.5
1415	360	91	287	324	-1.0	1.1	2.67	105	-11	0.47	1.56	119	4.5	603.617	95	16.5
1430	375	93	294	326	-1.0	1.1	2.67	107	-11	0.47					97	16.5
1445	390	94	293	327	-1.0	1.1	2.67	108	-11	0.47					101	16.5
1500	405	95	294	326	-1.0	1.1	2.67	108	-11	0.47					101	16.5
1515	420	95	294	327	-1.0	1.1	2.67	109	-11	0.47					101	16.5
1530	435	95	293	326	-1.0	1.1	2.67	109	-11	0.47					101	16.5
1545	450	95	294	324	-1.0	1.1	2.67	109	-11	0.47					101	16.3
1600	465	95	297	324	-1.0	1.1	2.67	108	-11	0.47					100	16.5
1615	480	95	296	325	-1.0	1.1	2.67	108	-11	0.47					101	16.5
1630	495	95	296	325	-1.0	1.1	2.67	109	-11	0.47					101	16.5
1645	510	95	293	324	-1.0	1.1	2.67	107	-11	0.47					100	16.5

93C028.F02 9 (see also 181025-2.F02) Revised 06/16/93

Dilution Sampler Field Data
Stack Description and Parameters

Coal Creek Run No. N-50-72B   Date 7-28-93

Use defaults as required for presampling setup.   Operator Jun

Obtain by	Parameter	Value	Unit	Nomen.	Default
Calibration:	Probe Coeff. A	6.3425	—	A_p	See probe calibration summary
	Probe Coeff. B	1.8168	—	B_p	
	Probe Cal. Temp.	68	°F	$T_{cal.p}$	68
	Probe Cal. Press.	29.92	in. Hg	$P_{cal.p}$	29.92
	Orifice Coeff. A	0.0018	—	A_o	0.0018
80X5 CM 5-17-93	Orifice Coeff. B	1.9897	—	B_o	1.9897
	Orifice Cal. Temp.	68	°F	$T_{cal.o}$	68
	Orifice Cal. Press.	29.92	in. Hg	$P_{cal.o}$	29.92
Y factor 0.9832	Meter Box ΔH@	1.734	in. H_2O	ΔH@	1.7
	Pitot Coeff.	0.84	—	C_p	0.84
Measure:	Ambient Temp.	88	°F	T_a	90
	Barometer	28.96	in. Hg	P_b	29.92
	Stack Temp.	289	°F	T_s	220
	Static Press.	-.95	in. H_2O	P_s	−1.5
	Velocity Press.	1.1	in. H_2O	VP	1.8
	Stack Moist.	9	% vol	H_2O	17.3
	Chamber Temp.	103	°F	T_C	90
	Orifice Vacuum	-11	in. H_2O	V_o	−15
	Meter Box Temp.	105	°F	T_{dgm}	100
Specification:	Dilution Ratio	30	—	DR	30
	Nozzle Diameter	.178	in.	d	0.178
	Impactor Rate	.75	acfm	Q_i	0.75
Calculation:	Stack Velocity	4180	ft/min	V_s	
	Probe Flow	0.7224	acfm	$Q_{act.}$	
	Probe Flow	0.5080	scfm	$Q_{std.}$	
	Chamber Press.	2.6612	in. H_2O	P_C	
	Orifice Flow	16.493	acfm	Q_{oa}	
	Orifice Flow	15.050	scfm	Q_{os}	
	Orifice Press. Drop	0.4297	in. H_2O	P_O	
	Meter Box ΔH	1.596	in. H_2O	ΔH	

93C028.F01 (see also 92C042.F01, 181025-2.F01)
Revised 06/16/93

CHESTER ENVIRONMENTAL

PSDS LEAK RATE : 0.045   VAC 5" Hg

DATE : 7-25-93

INITIAL TARGET
P_c = 2.66
P_o = .43
ΔH = 1.60

1/2

Chester Environmental Dilution Sampling Data Sheet
Battelle/DOE—Coal Creek %H_2O = 8.9 MW_D = 30.68

Date	7-23-93
Location	SB
Run Number	N-SB-723
Operator	[illegible]
Ambient Temperature	90
Barometric Pressure (in. Hg)	28.96

Pitot Coeff.	0.81
Meter Box ΔH@	1.734
Nozzle Diameter (in.)	0.178
Dilution Ratio	30
Static Pressure (in. H_2O)	-.95

Filter IDs:

8x10	N-SB-MMS-728		
HEST			
Impactor	1	5	
	2	6	
	3	7	
	4	8	

Clock Time	Sampling Time	Amb. Temp. (°F)	Stack Temp. (°F)	Probe Temp. (°F)	Static Press. (in. H_2O)	Vel. Press. (in. H_2O)	Chamber Press. (in. H_2O)	Chamber Temp (°F)	Orifice Vacuum (in. H_2O)	Orifice Press. Drop (in. H_2O)	Meter Box ΔH (in. H_2O)	Meter Box Temp. (°F)	Meter Box Vac. (in. Hg)	Meter Box Meter Reading	Diluant Temp. (°F)	Diluant Press. (psig)
815	0	88	289	309	-.95	1.1	2.66	100	-11	0.43	1.60	101	2.5	605.458	97	15.0
830	15	88	289	324	-.95	1.1	2.66	103	-11	0.43	1.60	106	2.5	616.61	96	15.0
845	30	88	287	326	-.95	1.1	2.66	103	-11	0.43	1.61	115	2.5	628.21	96	15.0
900	45	88	288	324	-.95	1.1	2.66	103	-11	0.43	1.62	116	2.5	640.0	96	15.0
915	60	89	290	322	-.95	1.1	2.66	105	-11	0.43	1.62	116	2.5	653.0	97	15.0
930	75	90	289	326	-1.0	1.1	2.66	105	-11	0.43	1.62	116	2.5	664.3	97	15.0
945	90	90	287	324	-1.0	1.1	2.66	105	-11	0.43	1.62	116	2.5	675.1	96	15.0
1000	105	90	288	322	-1.0	1.1	2.66	105	-11	0.43	1.62	116	2.5	686.8	96	15.0
1015	120	90	289	324	-1.0	1.1	2.66	104	-11	0.43	1.62	118	2.5	698.7	95	15.0
1030	135	91	287	323	-.95	1.1	2.66	104	-11	0.43	1.62	118	2.5	710.3	95	15.0
1045	150	92	289	324	-.95	1.1	2.66	105	-11	0.43	1.62	118	2.5	721.1	98	15.0
1100	165	92	289	325	-.95	1.1	2.66	105	-11	0.43	1.62	118	2.5	733.1	98	15.0
1115	180	93	290	324	-.95	1.1	2.66	106	-11	0.43	1.62	118	2.5	745.0	97	15.0
1130	195	93	287	326	-.95	1.1	2.66	105	-11	0.43	1.62	118	2.5	756.1	98	15.0
1145	210	92	293	327	-.95	1.1	2.66	105	-11	0.43	1.62	118	2.5	767.8	97	15.0
1200	225	93	291	325	-1.0	1.1	2.66	105	-11	0.43	1.62	118	2.5	777.9	98	15.0
1215	240	94	290	326	-.95	1.1	2.66	106	-11	0.43	1.62	115	2.5		98	15.0
1230	255	95	291	324	-.95	1.1	2.66	107	-11	0.43	1.62	118	2.5	795.5	100	15.0

POWER FAILURE @ 1208 RESTART @ 1216

93C018.F02 9 (see also 181025-2.F02) Revised 06/16/93

IMPACTOR LEAK CHECK: PRE-TEST .007 / 10" Hg (RATE + VAC)
POST-TEST .005 / 10" Hg

2/2

Chester Environmental Dilution Sampling Data Sheet
Battelle/DOE—Coal Creek

Date	
Location	N SB-728
Run Number	
Operator	
Ambient Temperature	
Barometric Pressure (in. Hg)	

Pitot Coeff.	
Meter Box ΔH@	
Nozzle Diameter (in.)	
Dilution Ratio	
Static Pressure (in. H_2O)	

Filter IDs:

8×10		
HEST		
Impactor	1	5
	2	6
	3	7
	4	8

Clock Time	Sampling Time	Amb. Temp. (°F)	Stack Temp. (°F)	Probe Temp. (°F)	Static Press. (in. H_2O)	Vel. Press. (in. H_2O)	Chamber Press. (in. H_2O)	Chamber Temp (°F)	Orifice Vacuum (in. H_2O)	Orifice Press. Drop (in. H_2O)	Meter Box ΔH (in. H_2O)	Meter Box Temp. (°F)	Meter Box Vac. (in. Hg)	Meter Box Meter Reading	Diluant Temp. (°F)	Diluant Press. (psig)
1245	270	95	291	327	-.95	1.1	2.66	108	~~0.43~~	0.43	1.62	118	2.5	907.3	101	15.0
1300	285	95	289	326	-.95	1.1	2.66	108	-11	0.43	1.62	118	2.5	920.6	101	15.0
1315	300	96	289	325	-.95	1.1	2.66	109	-11	0.43	1.62	118	2.5	930.5	101	15.0
1330	315	95	292	327	-.95	1.1	2.66	108	-11	0.43	1.62	118	2.5	941.3	101	15.0
1345	330	96	291	326	-.95	1.1	2.66	108	-11	0.43	1.62	118	2.5	852.7	101	15.0
1400	345	95	290	324	-1.6	1.1	2.66	108	-11	0.43	1.62	118	2.5	865.4	101	15.0
1415	360	94	288	323	-.95	1.1	2.66	108	-11	0.43	1.62	118	2.5	876.2	101	15.0
1430	375	93	287	324	-.95	1.1	2.66	108	-11	0.43	1.62	118	2.5	887.6	101	15.0
1445	390	94	286	323	-.95	1.1	2.66	108	-11	0.43	1.62	118	2.5	898.4	101	15.0
1500	405	95	287	324	-.95	1.1	2.66	109	-11	0.43	1.62	118	2.5	910.7	101	15.0
1515	420	94	291	327	-1.0	1.1	2.66	109	-11	0.43	1.62	118	2.5	922.3	101	15.0
1530	435	95	290	326	-.95	1.1	2.66	109	-11	0.43	1.62	118	2.5	933.7	102	15.0
1545	450	95	292	325	-.95	1.1	2.66	110	-11	0.43	1.62	119	2.5	944.2	102	15.0
1600	465	95	293	324	-.95	1.1	2.66	110	-11	0.43	1.62	118	2.5	955.6	101	15.0
1615	480	94	293	321	-.95	1.1	2.66	110	-11	0.43	1.62	119	2.5	965.4	102	15.0
1623	488	95	294	324	-1.0	1.1	2.66	109	-11	0.43	1.62	119	2.5	972.313	102	15.0

ADD SIMN TC MAKE UP FOR VTIME

93C028.F02 9 (see also 181025-2.F02) Revised 06/16/93

Dilution Sampler Field Data
Stack Description and Parameters

Coal Creek Run No. N-58-729 | Date 7-29-93

Use defaults as required for presampling setup. | Operator Jun

Obtain by	Parameter	Value	Unit	Nomen.	Default
Calibration:	Probe Coeff. A	6.3425	—	A_p	See probe calibration summary
	Probe Coeff. B	1.8168	—	B_p	
	Probe Cal. Temp.	68	°F	$T_{cal.p}$	68
	Probe Cal. Press.	29.92	in. Hg	$P_{cal.p}$	29.92
	Orifice Coeff. A	0.0018	—	A_o	0.0018
BOX 5	Orifice Coeff. B	1.9897	—	B_o	1.9897
	Orifice Cal. Temp.	68	°F	$T_{cal.o}$	68
	Orifice Cal. Press.	~~68~~ 29.92	in. Hg	$P_{cal.o}$	29.92
Y FACTOR = 0.9832	Meter Box ΔH@	1.734	in. H_2O	ΔH@	1.7
	Pitot Coeff.	0.84	—	C_p	0.84
Measure:	Ambient Temp.	79	°F	T_a	90
	Barometer	28.84	in. Hg	P_b	29.92
	Stack Temp.	289	°F	T_s	220
	Static Press.	−1.0	in. H_2O	P_s	−1.5
	Velocity Press.	1.05	in. H_2O	VP	1.8
	Stack Moist.	9	% vol	H_2O	17.3
	Chamber Temp.	100	°F	T_C	90
	Orifice Vacuum	−11	in. H_2O	V_o	−15
	Meter Box Temp.	105	°F	T_{dgm}	100
Specification:	Dilution Ratio	30	—	DR	30
	Nozzle Diameter	.178	in.	d	0.178
	Impactor Rate	.75	acfm	Q_i	0.75
Calculation:	Stack Velocity	4160	ft/min	V_s	
	Probe Flow	.7189	acfm	$Q_{act.}$	
	Probe Flow	.4873	scfm	$Q_{std.}$	
	Chamber Press.	2.5598	in. H_2O	P_C	
	Orifice Flow	16.3331	acfm	Q_{oa}	
	Orifice Flow	14.4276	scfm	Q_{os}	
	Orifice Press. Drop	0.4081	in. H_2O	P_O	
	Meter Box ΔH	1.554	in. H_2O	ΔH	

93C028.F01 (see also 92C042.F01, 181025-2.F01)
Revised 06/16/93

CHESTER ENVIRONMENTAL

PSDS LEAK RATE : 0.045
DATE : 7-25-93

VAC 5"

INITIAL PARAMETERS
P_c - 2.56
P_o = 0.41
ΔH = 1.55

Chester Environmental Dilution Sampling Data Sheet
Battelle/DOE—Coal Creek

% H_2O = 9.4, MW_s = 30.58

Date	2-29-93
Location	SB
Run Number	N-SB-729
Operator	Jum!
Ambient Temperature	80
Barometric Pressure (in. Hg)	28.84

29.40 @ 0745

Pitot Coeff.	.84
Meter Box ΔH@	1.734
Nozzle Diameter (in.)	0.178
Dilution Ratio	30
Static Pressure (in. H_2O)	-1.0

Filter IDs:

8×10	N-SB-MUM-729	
HEST		
Impactor	1	5
	2	6
	3	7
	4	8

Clock Time	Sampling Time	Amb. Temp. (°F)	Stack Temp. (°F)	Probe Temp. (°F)	Static Press. (in. H_2O)	Vel. Press. (in. H_2O)	Chamber Press. (in. H_2O)	Chamber Temp (°F)	Orifice Vacuum (in. H_2O)	Orifice Press. Drop (in. H_2O)	Meter Box ΔH (in. H_2O)	Meter Box Temp. (°F)	Meter Box Vac. (in. Hg)	Meter Box Meter Reading	Diluant Temp. (°F)	Diluant Press. (psig)
815	0	78	288	301	-1.0	1.05	2.56	96	-11	0.41	1.55	101	2.5	972.319	90	15.5
830	15	79	289	302	-1.0	1.05	2.56	97	-11	0.41	1.55	104	2.5	984.1	89	15.5
845	30	79	288	309	-1.0	1.05	2.56	98	-11	0.41	1.55	105	2.5	995.1	89	15.5
900	45	79	289	309	-1.0	1.05	2.56	98	-11	0.41	1.55	110	2.5	006.9	89	15.5
915	60	79	290	316	-1.0	1.05	2.56	98	-11	0.41	1.58	113	2.5	019.4	89	15.5
930	75	79	290	321	-1.0	1.05	2.56	98	-11	0.41	1.58	115	2.5	031.2	89	15.5
945	90	80	291	324	-1.0	1.05	2.56	99	-11	0.41	1.58	115	2.5	042.2	89	15.5
1000	105	80	290	326	-1.0	1.05	2.56	99	-11	0.41	1.58	115	2.5	54.2	89	15.5
1015	120	80	290	324	-1.0	1.05	2.56	98	-11	0.41	1.58	115	2.5	66.3	89	15.5
1030	135	80	291	326	-1.0	1.05	2.56	99	-11	0.41	1.58	115	2.5	77.9	89	15.5
1045	150	80	289	325	-1.0	1.05	2.56	98	-11	0.41	1.58	115	2.5	89.2	90	15.5
1100	165	80	289	326	-1.0	1.05	2.56	99	-11	0.41	1.58	115	2.5	101.3	90	15.5
1115	180	80	291	327	-1.0	1.05	2.56	100	-11	0.41	1.58	115	2.5	113.4	90	15.5
1130	195	80	290	326	-1.0	1.05	2.56	100	-11	0.41	1.58	115	2.5	124.4	90	15.5
1145	210	80	291	324	-1.0	1.05	2.56	100	-11	0.41	1.58	115	2.5	135.7	91	15.5
1200	225	80	290	326	-1.0	1.05	2.56	100	-11	0.41	1.58	115	2.5	148.1	91	15.5
1215	240	81	293	321	-0.85	1.05	2.56	101	-11	0.41	1.58	115	2.5	159.7	91	15.5
1230	255	82	290	324	-1.0	1.05	2.56	101	-11	0.41	1.58	115	2.5	172.5	91	16.0

93C028.F02.9 (see also 181023-2.F02) Revised 06/16/93

IMPACTOR LEAK CHECK ! PRE-TEST 0.007 / -02" (RATE + VAC)
POST-TEST 0.005 / 10"

Chester Environmental Dilution Sampling Data Sheet
Battelle/DOE—Coal Creek

Date	
Location	
Run Number	N-SB-729
Operator	
Ambient Temperature	
Barometric Pressure (in. Hg)	

Pitot Coeff.	
Meter Box ΔH@	
Nozzle Diameter (in.)	
Dilution Ratio	
Static Pressure (in. H_2O)	

Filter IDs:

8×10			
HEST			
Impactor	1	5	
	2	6	
	3	7	
	4	8	

Clock Time	Sampling Time	Amb. Temp. (°F)	Stack Temp. (°F)	Probe Temp. (°F)	Static Press. (in. H_2O)	Vel. Press. (in. H_2O)	Chamber Press. (in. H_2O)	Chamber Temp (°F)	Orifice Vacuum (in. H_2O)	Orifice Press. Drop (in. H_2O)	Meter Box ΔH (in. H_2O)	Meter Box Temp. (°F)	Meter Box Vac. (in. Hg)	Meter Box Meter Reading	Diluant Temp. (°F)	Diluant Press. (psig)
1245	270	82	289	325	-1.0	1.05	2.56	101	-11	0.41	1.58	115	2.5	184.7	91	15.5
1300	285	83	287	326	-1.0	1.05	2.56	101	-11	6.41	1.58	115	2.5	196.3	91	15.5
1315	300	83	291	322	-1.0	1.05	2.56	101	-11	0.41	1.58	115	2.5	208.3	91	15.5
1330	315	83	290	325	-1.0	1.05	2.56	101	-11	0.41	1.58	115	2.5	219.8	91	15.5
1345	330	84	290	325	-1.0	1.05	2.56	100	-11	0.41	1.58	115	2.5	232.0	92	15.5
1400	345	85	291	324	-1.0	1.05	2.56	101	-11	0.41	1.58	115	2.5	243.0	92	15.5
1415	360	85	289	326	-1.0	1.05	2.56	100	-11	0.41	1.58	116	2.5	254.1	92	15.5
1430	375	86	290	324	-1.0	1.05	2.56	102	-11	0.41	1.58	116	2.5	266.4	94	15.5
1445	390	87	290	326	-1.0	1.05	2.56	102	-11	0.41	1.58	116	2.5	276.9	93	15.5
1500	405	87	288	324	-1.0	1.05	2.56	102	-4	0.41	1.58	116	2.5	288.4	93	15.5
1515	420	86	287	326	-1.0	1.05	2.56	101	-11	0.41	1.58	117	2.5	299.9	94	15.5
1530	435	86	288	325	-1.0	1.05	2.56	101	-11	0.41	1.58	117	2.5	312.2	93	15.5
1545	450	86	291	324	-1.0	1.05	2.56	101	-11	0.41	1.58	117	2.5	323.4	93	15.5
1600	465	86	292	324	-1.0	1.05	2.56	100	-11	0.41	1.58	115	2.5	334.1	93	15.5
1615	480	85	287	329	-1.0	1.05	2.56	101	-11	0.41	1.58	115	2.5	347.718	92	15.5

93C028.F02 9 (see also 181025-2.F02)

Revised 06/16/93

Dilution Sampler Field Data
Stack Description and Parameters

Coal Creek Run No. N-SB-73d   Date 7-30-93

Use defaults as required for presampling setup.   Operator Jum

Obtain by	Parameter	Value	Unit	Nomen.	Default
Calibration:	Probe Coeff. A	6.3425	—	A_p	See probe calibration summary
	Probe Coeff. B	1.8168	—	B_p	
	Probe Cal. Temp.	68	°F	$T_{cal.p}$	68
	Probe Cal. Press.	29.92	in. Hg	$P_{cal.p}$	29.92
	Orifice Coeff. A	0.0018	—	A_o	0.0018
	Orifice Coeff. B	1.9897	—	B_o	1.9897
Box 5	Orifice Cal. Temp.	68	°F	$T_{cal.o}$	68
	Orifice Cal. Press.	29.92	in. Hg	$P_{cal.o}$	29.92
Y_{PACTO2}: 0.9832	Meter Box ΔH@	1.734	in. H_2O	ΔH@	1.7
	Pitot Coeff.	0.84	—	C_p	0.84
Measure:	Ambient Temp.	75	°F	T_a	90
	Barometer	28.93	in. Hg	P_b	29.92
	Stack Temp.	287	°F	T_s	220
	Static Press.	-1.05	in. H_2O	P_s	−1.5
	Velocity Press.	1.1	in. H_2O	VP	1.8
	Stack Moist.	9	% vol	H_2O	17.3
	Chamber Temp.	95	°F	T_C	90
	Orifice Vacuum	-11	in. H_2O	V_o	−15
	Meter Box Temp.	105	°F	T_{dgm}	100
Specification:	Dilution Ratio	30	—	DR	30
	Nozzle Diameter	0.178	in.	d	0.178
	Impactor Rate	0.75	acfm	Q_i	0.75
Calculation:	Stack Velocity	4246	ft/min	V_s	
	Probe Flow	0.7338	acfm	$Q_{act.}$	
	Probe Flow	0.5001	scfm	$Q_{std.}$	
	Chamber Press.	2.6689	in. H_2O	P_C	
	Orifice Flow	16.7293	acfm	Q_{oa}	
	Orifice Flow	14.8250	scfm	Q_{os}	
	Orifice Press. Drop	0.4294	in. H_2O	P_O	
	Meter Box ΔH	1.558	in. H_2O	ΔH	

93C028.F01 (see also 92C042.F01, 181025-2.F01)
Revised 06/16/93

PSDS LEAK RATE: 0.045
DATE: 7-25-93

CHESTER ENVIRONMENTAL

VAC 5"Hg

INITIAL TARGETS
$P_c = 2.67$
$P_o = 0.43$
$\Delta H = 1.56$

1/2

Chester Environmental Dilution Sampling Data Sheet
Battelle/DOE—Coal Creek

%H_2O = 8.4% MW_D = 30.56

Date	7-30-93
Location	513
Run Number	N-SB-730
Operator	JWM
Ambient Temperature	~~80~~ 75
Barometric Pressure (in. Hg)	28.93

Pitot Coeff.	0.84
Meter Box ΔH@	1.734
Nozzle Diameter (in.)	0.178
Dilution Ratio	30
Static Pressure (in. H_2O)	-1.05

Filter IDs:

8x10	N-SB-MMS-730		
HEST			
Impactor	1	5	
	2	6	
	3	7	
	4	8	

PURGE @ 0810

Clock Time	Sampling Time	Amb. Temp. (°F)	Stack Temp. (°F)	Probe Temp. (°F)	Static Press. (in. H_2O)	Vel. Press. (in. H_2O)	Chamber Press. (in. H_2O)	Chamber Temp (°F)	Orifice Vacuum (in. H_2O)	Orifice Press. Drop (in. H_2O)	Meter Box ΔH (in. H_2O)	Meter Box Temp. (°F)	Meter Box Vac. (in. Hg)	Meter Box Meter Reading	Diluant Temp. (°F)	Diluant Press. (psig)
830	0	75	287	302	-1.05	1.1	2.67	91	-11	0.43	1.56	100	2.0	348.031	83	17
845	15	75	288	304	-1.05	1.1	2.67	92	-11	0.43	1.56	102	2.0	359.3	83	17
900	30	75	287	336	-1.05	1.1	2.67	92	-11	0.43	1.60	110	2.0	370.8	83	17
915	45	75	291	329	-1.05	1.1	2.67	93	-11	0.43	1.60	110	2.0	382.1	83	17
930	60	76	290	327	-1.05	1.1	2.67	92	-11	0.43	1.60	110	2.0	393.1	83	17
945	75	77	284	326	-1.05	1.1	2.67	92	-11	0.43	1.60	110	2.0	404.4	82	17
1000	90	77	288	324	-1.05	1.1	2.67	93	-11	0.43	1.60	110	2.0	415.5	82	17
1015	105	76	285	321	-1.05	1.1	2.67	93	-11	0.43	1.60	110	2.0	428.7	83	17
1030	120	76	286	324	-1.00	1.1	2.67	93	-11	0.43	1.60	111	2.0	441.6	83	17
1045	135	76	289	326	-1.05	1.1	2.67	93	-4	0.43	1.60	111	2.0	453.2	83	17
1100	150	76	290	325	-1.05	1.1	2.67	92	-11	0.43	1.60	112	2.0	465.5	83	17
1115	165	76	291	324	-1.05	1.1	2.67	92	-11	0.43	1.60	112	2.0	477.1	83	17
1130	180	76	289	324	-1.05	1.1	2.67	92	-11	0.43	1.60	112	2.0	488.4	83	17
1145	195	77	284	326	-1.05	1.1	2.67	93	-11	0.43	1.60	112	2.0	499.3	83	17
1200	210	76	284	324	-1.05	1.1	2.67	92	-4	0.43	1.60	113	2.0	513.1	82	17
1215	225	76	284	325	-1.05	1.1	2.67	92	-11	0.43	1.60	114	2.0	525.3	82	17
1230	240	77	287	324	-1.05	1.1	2.67	92	-11	0.43	1.60	114	2.0	535.7	81	17
1245	255	77	289	326	-1.05	1.1	2.67	92	-11	0.43	1.60	114	2.0	547.9	82	17

93C028.F02 9 (see also 181025-2.F02)   Revised 06/16/93

IMPACTOR LEAK CHECK : PRE-TEST 0.005/10" (RATE + VAC)
POST-TEST ____

2/2

Chester Environmental Dilution Sampling Data Sheet
Battelle/DOE—Coal Creek

Date	
Location	~~#~~ SB
Run Number	IV-SB-730
Operator	[illegible]
Ambient Temperature	
Barometric Pressure (in. Hg)	

Pitot Coeff.	
Meter Box ΔH@	
Nozzle Diameter (in.)	
Dilution Ratio	
Static Pressure (in. H_2O)	

Filter IDs:

8×10		
HEST		
Impactor	1	5
	2	6
	3	7
	4	8

Clock Time	Sampling Time	Amb. Temp. (°F)	Stack Temp. (°F)	Probe Temp. (°F)	Static Press. (in. H_2O)	Vel. Press. (in. H_2O)	Chamber Press. (in. H_2O)	Chamber Temp (°F)	Orifice Vacuum (in. H_2O)	Orifice Press. Drop (in. H_2O)	Meter Box ΔH (in. H_2O)	Meter Box Temp. (°F)	Meter Box Vac. (in. Hg)	Meter Box Meter Reading	Diluant Temp. (°F)	Diluant Press. (psig)
1300	270	77	286	324	-1.05	1.1	2.67	92	-11	0.43	1.60	114	2.0	560.4	82	17
1315	285	78	288	324	-1.00	1.1	2.67	91	-11	0.43	1.60	114	2.0	571.3	82	17
1330	300	78	289	326	-1.05	1.1	2.67	91	-11	0.43	1.60	115	2.0	583.3	81	17
1345	315	78	288	327	-1.05	1.1	2.67	91	-11	0.43	1.60	115	2.0	595.7	81	17
1400	330	77	287	326	-1.05	1.1	2.67	91	-11	0.43	1.60	115	2.0	607.2	82	17
1415	345	77	288	324	-1.05	1.1	2.67	92	-11	0.43	1.60	115	2.0	619.1	82	17
1430	360	77	285	325	-1.05	1.1	2.67	91	-11	0.43	1.60	115	2.0	630.4	82	17
1445	375	76	284	327	-1.05	1.1	2.67	91	-11	0.43	1.60	115	2.0	642.0	81	17
1500	390	77	287	326	-1.05	1.1	2.67	92	-11	0.43	1.60	115	20	652.7	81	17
1515	405	76	286	324	-1.05	1.1	2.67	91	-11	0.43	1.60	115	2.0	663.1	81	17
1530	420	75	287	326	-1.05	1.1	2.67	92	-11	0.43	1.60	115	2.0	674.4	82	17
1545	435	74	286	327	-1.05	1.1	2.67	92	-11	0.43	1.60	115	2.0	685.5	82	17
1600	450	75	287	326	-1.05	1.1	2.67	91	-11	0.43	1.60	115	2.0	696.8	81	17
1615	465	74	285	325	-1.05	1.1	2.67	91	-11	0.43	1.60	115	2.0	709.4	81	17
1630	480	74	289	324	-1.05	1.1	2.67	91	-11	0.43	1.60	115	2.0	725.686	81	17

1420-1425 [illegible]

93C028.F02 9 (see also 181025-2.F02)

Revised 06/16/93

Dilution Sampler Field Data
Stack Description and Parameters

Coal Creek Run No. N-SB-731 | Date 7-31-93

Use defaults as required for presampling setup. | Operator JWM

Obtain by	Parameter	Value	Unit	Nomen.	Default
Calibration:	Probe Coeff. A	6.3425	—	A_p	See probe calibration summary
	Probe Coeff. B	1.8168	—	B_p	
	Probe Cal. Temp.	68	°F	$T_{cal.p}$	68
	Probe Cal. Press.	29.92	in. Hg	$P_{cal.p}$	29.92
	Orifice Coeff. A	0.0018	—	A_o	0.0018
	Orifice Coeff. B	1.9897	—	B_o	1.9897
BOX 5	Orifice Cal. Temp.	68	°F	$T_{cal.o}$	68
	Orifice Cal. Press.	29.92	in. Hg	$P_{cal.o}$	29.92
Y_{FACTOR} = 0.9832	Meter Box ΔH@	1.734	in. H_2O	ΔH@	1.7
	Pitot Coeff.	0.84	—	C_p	0.84
Measure:	Ambient Temp.	77	°F	T_a	90
	Barometer	29.02	in. Hg	P_b	29.92
	Stack Temp.	284	°F	T_s	220
	Static Press.	-1.0	in. H_2O	P_s	−1.5
	Velocity Press.	1.05	in. H_2O	VP	1.8
	Stack Moist.	9	% vol	H_2O	17.3
	Chamber Temp.	85	°F	T_C	90
	Orifice Vacuum	-11	in. H_2O	V_o	−15
	Meter Box Temp.	95	°F	T_{dgm}	100
Specification:	Dilution Ratio	30	—	DR	30
	Nozzle Diameter	0.178	in.	d	0.178
	Impactor Rate	0.75	acfm	Q_i	0.75
Calculation:	Stack Velocity	4133	ft/min	V_s	
	Probe Flow	0.7143	acfm	$Q_{act.}$	
	Probe Flow	0.4904	scfm	$Q_{std.}$	
	Chamber Press.	2.5567	in. H_2O	P_C	
	Orifice Flow	15.8763	acfm	Q_{oa}	
	Orifice Flow	14.5026	scfm	Q_{os}	
	Orifice Press. Drop	0.3987	in. H_2O	P_O	
	Meter Box ΔH	1.62	in. H_2O	ΔH	

93C028.F01 (see also 92C042.F01, 181025-2.F01)
Revised 06/16/93

PSDS LEAK RATE : 0.045
DATE : 7-25-93

CHESTER ENVIRONMENTAL

VAC 05

$P_c = 2.56$
$P_o = 0.40$
$\Delta H = 1.62$

1/2

Chester Environmental Dilution Sampling Data Sheet
Battelle/DOE—Coal Creek

% H_2O = 9.4, MW_D = 30.50

Date	7-31-93
Location	SB
Run Number	N-SB-731
Operator	JUM
Ambient Temperature	
Barometric Pressure (in. Hg)	29.02

Pitot Coeff.	0.84
Meter Box ΔH@	1.734
Nozzle Diameter (in.)	0.178
Dilution Ratio	30
Static Pressure (in. H_2O)	-1.0

Filter IDs:

8x10	IV-SB-MUM-731		
HEST			
Impactor	1	5	
	2	6	
	3	7	
	4	8	

PURGED @ 745

Clock Time	Sampling Time	Amb. Temp. (°F)	Stack Temp. (°F)	Probe Temp. (°F)	Static Press. (in. H_2O)	Vel. Press. (in. H_2O)	Chamber Press. (in. H_2O)	Chamber Temp (°F)	Orifice Vacuum (in. H_2O)	Orifice Press. Drop (in. H_2O)	Meter Box ΔH (in. H_2O)	Meter Box Temp. (°F)	Meter Box Vac. (in. Hg)	Meter Box Meter Reading	Diluant Temp. (°F)	Diluant Press. (psig)
815	0	75	282	296	-1.0	1.05	2.56	86	[illegible]	0.04	1.62	92	2.5	727.258	81	7.5
830	15	75	282	299	-1.0	1.05	2.56	86	-11	0.04	1.62	98	2.5	739.7	81	7.5
845	30	75	284	317	-1.0	1.05	2.56	89	-11	0.04	1.62	102	2.5	751.7	81	7.5
900	45	76	285	324	-1.0	1.05	2.56	90	-11	0.04	1.64	105	2.5	763.1	81	7.5
915	60	76	283	326	-1.0	1.05	2.56	91	-11	0.04	1.64	108	2.5	774.4	81	7.5
930	75	76	286	327	-1.0	1.05	2.56	90	-11	0.04	1.64	110	2.5	785.7	81	7.5
945	90	76	284	325	-1.0	1.05	2.56	91	-11	0.04	1.64	110	2.5	797.1	81	7.5
1000	105	76	287	324	-1.0	1.05	2.56	91	-11	0.04	1.64	110	2.5	809.4	81	7.5
1015	120	76	286	324	-1.0	1.05	2.56	90	-11	0.04	1.64	110	2.5	821.4	81	14.5
1030	135	77	285	324	-1.0	1.05	2.56	89	-11	0.04	1.64	110	2.5	833.0	81	14.5
1045	150	79	286	326	-1.0	1.05	2.56	90	-11	0.04	1.64	110	2.5	845.0	81	14.5
1100	165	80	288	327	-1.0	1.05	2.56	91	-11	0.04	1.64	110	2.5	856.1	82	14.5
1115	180	80	287	326	-1.0	1.05	2.56	91	-11	0.04	1.64	110	2.5	867.8	82	14.5
1130	195	80	285	325	-1.0	1.05	2.56	90	-11	0.04	1.64	110	2.5	879.7	81	14.5
1145	210	80	286	324	-1.0	1.05	2.56	93	-11	0.40	1.64	110	2.5	890.3	83	12.0
1200	225	80	287	321	-1.0	1.05	2.56	94	-11	0.40	1.64	110	2.5	902.2	84	12.0
1215	240	81	286	325	-1.0	1.05	2.56	96	-11	0.40	1.64	110	2.5	915.1	85	12.0
1230	255	82	287	324	-1.0	1.05	2.56	96	-11	0.40	1.64	110	2.5	922.4	85	12.0

93C028.F02 9 (see also 181025-2.F02)

IMPACTOR LEAK CHECK ! PRE-TEST 0.007 / 10" (RATE + VAC)
POST-TEST

Revised 06/16/93

4/2

Chester Environmental Dilution Sampling Data Sheet
Battelle/DOE—Coal Creek

Date	
Location	
Run Number	N-5B-731
Operator	
Ambient Temperature	
Barometric Pressure (in. Hg)	

Pitot Coeff.	
Meter Box ΔH@	
Nozzle Diameter (in.)	
Dilution Ratio	
Static Pressure (in. H_2O)	

Filter IDs:

8×10			
HEST			
Impactor	1	5	
	2	6	
	3	7	
	4	8	

Clock Time	Sampling Time	Amb. Temp. (°F)	Stack Temp. (°F)	Probe Temp. (°F)	Static Press. (in. H_2O)	Vel. Press. (in. H_2O)	Chamber Press. (in. H_2O)	Chamber Temp (°F)	Orifice Vacuum (in. H_2O)	Orifice Press. Drop (in. H_2O)	Meter Box ΔH (in. H_2O)	Meter Box Temp. (°F)	Meter Box Vac. (in. Hg)	Meter Box Meter Reading	Diluant Temp. (°F)	Diluant Press. (psig)
1245	270	83	286	325	-1.0	1.05	2.56	96	-11	0.40	1.64	110	2.5	939.3	85	12.0
1300	285	84	283	326	-1.0	1.05	2.56	97	-11	0.40	1.64	110	2.5	951.7	85	12.0
1315	300	85	284	327	-1.0	1.05	2.56	98	-11	0.41	1.60	110	2.5	963.1	87	12.0
1330	315	86	283	324	-1.0	1.05	2.56	98	-11	0.41	1.60	110	2.5	975.0	89	12.0
1345	330	86	285	327	-1.0	1.05	2.56	97	-11	0.41	1.60	110	2.5	986.8	90	12.0
1400	345	86	288	324	-1.0	1.05	2.56	97	-11	0.41	1.60	110	2.5	998.7	91	12.0
1415	360	86	287	324	-1.0	1.05	2.56	98	-11	0.41	1.60	110	2.5	010.3	91	12.0
1430	375	86	286	327	-1.0	1.05	2.56	98	-11	0.41	1.60	110	2.5	22.2	92	12.0
1445	390	87	285	326	-1.0	1.05	2.56	97	-4	0.41	1.60	110	2.5	33.9	92	12.0
1500	405	88	284	325	-1.0	1.05	2.56	97	-11	0.41	1.60	110	2.5	45.6	92	12.0
1515	420	89	287	324	-1.0	1.05	2.56	96	-11	0.41	1.60	110	2.5	56.9	92	12.0
1530	435	89	286	326	-1.0	1.05	2.56	96	-11	0.41	1.60	110	2.5	68.7	92	12.0
1545	450	88	284	324	-1.0	1.05	2.56	97	-11	0.41	1.60	110	2.5	81.1	92	12.0
1600	465	88	286	325	-1.0	1.05	2.56	96	-11	0.41	1.60	110	2.5	92.6	92	12.0
1615	480	89	285	324	-1.0	1.05	2.56	97	-4	0.41	1.60	110	2.5	105.436	91	12.0

Process ... @ 8 min

(Pitots did not shut down)

93C028.F02 9 (see also 181025-2.F02)

Revised 06/16/93

D-11: High-Volume Sampler (Soot Blowing Particulate Sampling)

STACK SAMPLING DATA SHEET

CLIENT Battelle
TEST UNIT Location 5A
PROJECT NO. 93C02B
CONTROL BOX OPERATOR MRP
BAROMETRIC PRESSURE 29.0

TEST DATE 7/27/93
TEST NO. N-5A-HVS-727-1
NOZZLE (SIZE,#) .872
STATIC PRESSURE ~1" H_2O
PORT DIRECTION A

ORIFICE CORRECTION —
METER CORRECTION —
CALIBRATION DATE
PITOT CORRECTION .89, B71
CONTROL BOX NO.

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. B71, pitot
FILTER NO. —
STACK DIA.

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
	0530	—	1.45	.052		—	120		292				
	0540	—		.058		—	170		295				
	0550	—		.058		—	187		293				
	0600	—		.060		—	205		290				
	0610	—		.060		—	205		290				
	0620	—		.060		—	205		289				
	0630	—		.060		—	205		290				
	0640	—		.060		—	200		289				
	0650	—		.060		—	200		290				
	0700	—		.060		—	200		290				
	0710	—		.060		—	200		290				
	0720	—		.060		—	200		290				
	0730	—		.060		—	200		290				
		Note: Soot Blowing finished @ 0650, Not communicated to stack.											Estimates:
													MW= 28.0
													%H2O= 9%

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		ΔP across orifice
After		=0 @ 30% variac

PITOT LEAK CHECK

	Positive	Negative
Before	✓ 3.5	✓ 3.5
After	✓ 3.2	✓ 4.1

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

KEYSTONE

AQE 2/92

.872"

STACK SAMPLING DATA SHEET

CLIENT Battelle
TEST UNIT Location 5A
PROJECT NO. 93C028
CONTROL BOX OPERATOR MRP
BAROMETRIC PRESSURE 28.94

TEST DATE 7/27/93
TEST NO. N-5A-HVS-727-2
NOZZLE (SIZE,#) (Stand Conditions)
STATIC PRESSURE -1" H_2O
PORT DIRECTION A

ORIFICE CORRECTION —
METER CORRECTION —
CALIBRATION DATE
PITOT CORRECTION ~~0~~ .84
CONTROL BOX NO. —

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. P7.1, pitot
FILTER NO.
STACK DIA.

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
	1327,0	—	1.1	1.5cfm	.038	—	150	—	290	—	—	—	
	10				.036		185		291				
	20				.036		193		291				
	30				.036		200		292				
	40				.036		200		290				
	50				.036		204		289				
	1427 60				.036		203		290				
	70				.036		204		290				
	80				.036		205		288				
	90				.036		205		289				
	100				.036		205		292				
	110				.036		205		290				
	1527 120				.036		205		291				
	130				.036		205		289				
	140				.036		205		291				Estimates:
	150				.036		205		292				MW= 28.5
	160				.036		205		290				%H2O= 9%
	170/180				.036/.036		205/205		289/290				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before	✓ 3.3	✓ 3.5
After	✓ 3.2	✓ 3.7

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

KEYSTONE

AQE 2/92

N-5A-HVS-729-1 (Soot Blow)

STACK SAMPLING DATA SHEET

CLIENT	Battelle	TEST DATE	7-29-93	ORIFICE CORRECTION	—	HOT BOX NO.	—
TEST UNIT	5 B A	TEST NO.	HI-VOC B	METER CORRECTION	—	COLD BOX NO.	—
PROJECT NO.	930028	NOZZLE (SIZE,#)	.872	CALIBRATION DATE	—	PROBE NO.	—
CONTROL BOX OPERATOR	JWM	STATIC PRESSURE	-1.0	PITOT CORRECTION	—	FILTER NO.	
BAROMETRIC PRESSURE	28.84	PORT DIRECTION	—	CONTROL BOX NO.	—	STACK DIA.	

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
SINGLE	0600		1.1	0.0375	0.0375	90			286				START SOOT BLOW
POINT	0615		1.1	0.0375	0.0375	120			287				
	0630		1.1			140			289				
	0645		1.1			150			288				
	0700		1.1			150			291				
	0715		1.1			159			287				
	0730		1.1			165			286				
	0745		1.1			170			288				
	0800		1.1			175			290				
													Estimates:
													MW=
													%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 2/92

KEYSTONE

KEYSTONE ENVIRONMENTAL RESOURCES / AIR QUALITY ENGINEERING
STACK SAMPLING DATA SHEET

CLIENT	BATTELLE	TEST DATE	7-29-93	ORIFICE CORRECTION (ΔH@)	—	HOT/COLD BOX NO.	—
TEST UNIT	5A	TEST NO.	N-5A-HVS-729-2	METER CORRECTION (Y)	—	PROBE NO.	—
PROJECT NO.	93C028	NOZZLE (SIZE,#)	.8	CALIBRATION DATE	—	FILTER NO.	[redacted]
TEST CREW	MRP	STATIC PRESSURE	-1.0	PITOT CORRECTION	—	STACK DIA.	
BAROMETRIC PRESSURE	28.98	PORT DIRECTION	—	CONTROL BOX NO.	—	PORT SIZE	

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Required (in. H2O)	Orifice ΔH Actual (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°F)	Hot Box Temp. (°F)	Comments
Single pt!	1250		1.1		.032		140		290				min./point
	1300				.033		153		291				
	1310				.033		162		292				
	1320				.033		163		291				
	1330						163		290				
	1340						163		290				
	1350								291				
	1400								290				
	1410								289				
	1420								289				
	1430								290				
	1440								290				
	1450								289				
	1500								291				
	1510								291				
	1520								292				Estimates:
	1530								290				MW=
	1540/1550								290/291				%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

GAS	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 6/92

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

STACK SAMPLING DATA SHEET

PLANT: Niles, Ohio DATE: 7-31-93 ΔH@: — HOT BOX NO.: —

LOCATION: — TEST NO.: NI-5B-HVS-731-0 METER CORRECTION: — COLD BOX NO.: —

ACTIVITY NO: 93-C028 NOZZLE: .872 PITOT CORRECTION: — PROBE NO.: —

CONTROL BOX OPERATOR D. Brown STATIC PRESSURE Ps: -1.1 CONTROL BOX NO.: — FILTER NO.: —

PROBE HANDLER — PORT DIRECTION: NOMOGRAPH SET POINT: — STACK DIA.:

CLEAN UP — BAROMETRIC PRESSURE 29.02 LENGTHS OF UMBILICAL ___ x 25' ___ x 50'

Point	Time	Meter Reading (dry) CF	Velocity HD In. H_2O	Blue tube ΔP ~~Orifice ΔH~~ In. H_2O Req.	Act.	Meter Temp., T_m °F In	Out	Vacuum V_m In. Hg	Stack Temp. T_s °F	Probe Temp. T_p °F	Blue tube temp ~~Imp. Temp.~~ ~~T_I~~ ~~°C~~/(°F)	Hot Box Temp. T_H °F	Comments
	0600	1	1.1		0.0375				287	382	160		
	0610		1.1		0.0375				290	373	165		
	0620		1.1		0.0375				289	398	165		
	0630		1.1		0.0375				288	398	165		
	0640		1.1		0.0375				288	401	165		
	0650		1.1		0.0375				287	398	165		
	0700		1.1		0.0375				287	397	165		
	0710		1.1		0.0375				288	397	165		
	0720		1.1		0.0375				289	397	165		
	0730		1.1		0.0375				289	378	165		
	0740		1.1		0.0375				287	398	165		
	0750		1.1		0.0375				287	398	165		
	0800		1.1		0.0375				287	379	165		
	0803												

LEAK CHECK

	In Hg	Rate
Before		
After		

ORSAT

	1	2	3
CO_2			
O_2			
CO			
N			

Impinger No.	Final	Initial	Difference
1			
2			
3			
4			
5			

STACK SAMPLING DATA SHEET

CLIENT BATTELLE
TEST UNIT BOILER 2, LOC 5A
PROJECT NO. 93C02B
CONTROL BOX OPERATOR MRP
BAROMETRIC PRESSURE 29.02

TEST DATE 7/31/93
TEST NO. N-5A-HVS-731-2
NOZZLE (SIZE,#) .872
STATIC PRESSURE -1.1
PORT DIRECTION A

ORIFICE CORRECTION —
METER CORRECTION —
CALIBRATION DATE —
PITOT CORRECTION —
CONTROL BOX NO. BLUE TUBE

HOT BOX NO. —
COLD BOX NO. —
PROBE NO. —
FILTER NO.
STACK DIA. —

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
1pt.	1245	—	1.1	—	.037	—	145	—	289	*362	—	—	
	1300		1.1		.037	—	155		286	T/c broke loose from probe. probe heat on "High"			
	1315		1.1		.038		165		288				
	1330		1.1		.038		165		288				
	1345		1.1		.038		165		290				
	1400		1.1		.038		165		291				
	1415		1.1		.038		165		289				
	1430		1.1		.038		165		289				
	1445		1.1		.038		165		289				
	1500		1.1		.038		165		290				
	1515		1.1		.038		165		289				
	1530		1.1		.038		165		290				
	1545 50		1.1		.038		165		291				stop due to shear pin @ 1540 restart @ 1545
													Estimates:
													MW=
													%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

* probe preheated before starting testing

KEYSTONE

AQE 2/92

D-12: Flue Gas Sampling Calculation Spreadsheets

NILES BOILER, ESP INLET, LOCATION 4

			1	2	3
	RUN NO.		1	2	3
	TEST DATE		7/26	7/27	7/28
	SAMPLING TIME, 24 HOUR CLOCK	FROM	1417	1120	1020
		TO	2017	2013	1731
DN	SAMPLING NOZZLE DIAMETER, IN.		0.247	0.182	0.182
TT	NET TIME OF TEST, MIN.		360	360	360
PB	BAROMETRIC PRESSURE, IN. HG		28.84	28.82	28.84
PM	AVG. ORIFICE PRESSURE DROP, IN. H2O		2.00	0.80	0.80
VM	VOLUME OF DRY GAS SAMPLED AT METER CONDITIONS, CF (DRY)		249.6	167.6	174.1
TM	AVG. GAS METER TEMPERATURE, F		95	92	90
VMSTD	VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS, NCF (DRY)		214.4	144.2	150.4
VW	TOTAL H2O COLLECTED IN IMPINGERS AND SILICA GEL, ML		449.0	550.0	458.0
VWGAS	VOLUME OF H2O VAPOR COLLECTED,NCF		19.7	24.2	20.1
M	MOISTURE IN STACK GAS BY VOLUME, PERCENT		8.43	14.37	11.81
MD	MOLECULAR FRACTION OF DRY GAS		0.92	0.86	0.88
CO2	STACK GAS C02, VOL PERCENT DRY		14.5	14.5	12.0
O2	STACK GAS O2, VOL PERCENT DRY		4.0	4.1	4.4
CO	STACK GAS CO, VOL PERCENT DRY		0.0	0.0	0.0
N2	STACK GAS N2, VOL PERCENT DRY		81.5	81.4	83.6
EA	STACK GAS EXCESS AIR, PERCENT		22.8	23.6	24.9
MWD	MOLECULAR WEIGHT OF STACK GAS, DRY BASIS		30.5	30.5	30.1
MW	MOLECULAR WEIGHT OF STACK GAS, WET BASIS		29.4	28.7	28.7
CP	PITOT TUBE COEFFICIENT		0.85	0.85	0.85
TS	AVG. STACK TEMPERATURE, F		310	301	282
NP	NET SAMPLING POINTS		24	26	25

NILES BOILER, ESP INLET, LOCATION 4

			1	2	3
	RUN NO.		1	2	3
	TEST DATE		7/26	7/27	7/28
	SAMPLING TIME, 24 HOUR CLOCK	FROM	1417	1120	1020
		TO	2017	2013	1731
PST	STATIC PRESSURE OF STACK GAS, IN. HG.		0.05	0.05	0.05
PS	STACK GAS ABS. PRESSURE, IN. HG		28.89	28.87	28.89
VS	STACK GAS VELOCITY AT STACK CONDITIONS, FPM		3518	3803	3823
AS	STACK AREA, SQ. IN.		16277.	16277.	16277.
QS	STACK GAS VOLUMETRIC FLOW RATE AT NORMAL CONDITIONS, NCFM (DRY)		224732	229670	243876
QA	STACK GAS VOLUMETRIC FLOW RATE AT STACK CONDITIONS, ACFM (WET)		397626	429836	432141
I	ISOKINETIC RATE, PERCENT		90.0	109.1	107.2
MF	PARTICULATE MASS--PROBE, CYCLONE, AND FILTER, MG		0.0	8597.0	0.0
CAN	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/NCF (DRY)		0.000	0.918	0.000
CAT	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/ACF (WET)		0.000	0.491	0.000
CAN3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/NCF (DRY)		0.000	0.979	0.000
CAT3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/ACF (WET)		0.000	0.523	0.000
CAW	PARTICULATE EMISSIONS--PROBE, CYCLONE AND FILTER, LB/HR		0.00	1807.70	0.00

NILES BOILER, ESP INLET, LOCATION 4

RUN NO. TEST DATE	1 7/26	2 7/27	3 7/28
VOLUME OF GAS SAMPLED, NCF (DRY)	214.4	144.2	150.4
MOISTURE FRACTION VOLUME, PERCENT	8.4	14.4	11.8
AVERAGE STACK TEMPERATURE, F	310	301	282
STACK VOLUMETRIC FLOW RATE, NCFM (DRY)	224732	229670	243876
STACK VOLUMETRIC FLOW RATE, ACFM (WET)	397626	429836	432141
ISOKINETIC RATE, PERCENT	90.0	109.1	107.2
EXCESS AIR, PERCENT	22.8	23.6	24.9
PARTICULATE MASS - PROBE,CYC,FILTER CATCH,			
MG	0.0	8597.0	0.0
PARTICULATE LOADING, GR/NCF AT STACK O2 (DRY)	0.000	0.918	0.000
PARTICULATE LOADING, GR/ACF AT STACK O2 (WET)	0.000	0.491	0.000
PARTICULATE LOADING, GR/NCF AT 3% O2 (DRY)	0.000	0.979	0.000
PARTICULATE LOADING, GR/ACF AT 3% O2 (WET)	0.000	0.523	0.000
PARTICULATE EMISSIONS, LB/HR	0.0	1807.7	0.0

NILES BOILER, ESP INLET, LOCATION 4

RUN NO.	1	2	3
TEST DATE	7/26	7/27	7/28
VOLUME OF GAS SAMPLED, NCM	6.07	4.08	4.26
MOISTURE FRACTION VOLUME, PERCENT	8.4	14.4	11.8
AVERAGE STACK TEMPERATURE, C	154	149	138
STACK VOLUMETRIC FLOW RATE, NCMM	6363	6503	6905
STACK VOLUMETRIC FLOW RATE, CMM	11259	12171	12236
ISOKINETIC RATE, PERCENT	90.0	109.1	107.2
EXCESS AIR, PERCENT	22.8	23.6	24.9
PARTICULATE MASS - PROBE,CYC,FILTER CATCH, MG	0.0	8597.0	0.0
PARTICULATE LOADING, MG/NCM AT STACK O2 (DRY)	0.0	2101.7	0.0
PARTICULATE LOADING, MG/CM AT STACK O2 (WET)	0.0	1122.9	0.0
PARTICULATE LOADING, MG/NCM AT 3% O2 (DRY)	0.0	2239.3	0.0
PARTICULATE LOADING, MG/CM AT 3% O2 (WET)	0.0	1196.4	0.0
PARTICULATE EMISSIONS, KG/HR	0.0	820.0	0.0

NILES BOILER, ESP INLET, LOCATION 4

	RUN NO.	4	5	6
	TEST DATE	7/29	7/30	7/31
	SAMPLING TIME, 24 HOUR CLOCK FROM	926	915	900
	TO	1525	1530	1517
DN	SAMPLING NOZZLE DIAMETER, IN.	0.182	0.182	0.182
TT	NET TIME OF TEST, MIN.	360	360	360
PB	BAROMETRIC PRESSURE, IN. HG	28.76	28.77	28.92
PM	AVG. ORIFICE PRESSURE DROP, IN. H2O	0.80	0.80	1.00
VM	VOLUME OF DRY GAS SAMPLED AT METER CONDITIONS, CF (DRY)	165.0	159.8	171.8
TM	AVG. GAS METER TEMPERATURE, F	82	66	80
VMSTD	VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS, NCF (DRY)	144.2	144.0	151.7
VW	TOTAL H2O COLLECTED IN IMPINGERS AND SILICA GEL, ML	458.0	336.0	297.0
VWGAS	VOLUME OF H2O VAPOR COLLECTED,NCF	20.1	14.8	13.1
M	MOISTURE IN STACK GAS BY VOLUME, PERCENT	12.25	9.30	7.93
MD	MOLECULAR FRACTION OF DRY GAS	0.88	0.91	0.92
CO2	STACK GAS C02, VOL PERCENT DRY	14.8	14.7	14.4
O2	STACK GAS O2, VOL PERCENT DRY	4.0	4.1	4.4
CO	STACK GAS CO, VOL PERCENT DRY	0.0	0.0	0.0
N2	STACK GAS N2, VOL PERCENT DRY	81.2	81.2	81.2
EA	STACK GAS EXCESS AIR, PERCENT	22.9	23.6	25.8
MWD	MOLECULAR WEIGHT OF STACK GAS, DRY BASIS	30.5	30.5	30.5
MW	MOLECULAR WEIGHT OF STACK GAS, WET BASIS	29.0	29.4	29.5
CP	PITOT TUBE COEFFICIENT	0.85	0.85	0.85
TS	AVG. STACK TEMPERATURE, F	292	296	282
NP	NET SAMPLING POINTS	24	24	25

NILES BOILER, ESP INLET, LOCATION 4

	RUN NO.	4	5	6
	TEST DATE	7/29	7/30	7/31
	SAMPLING TIME, 24 HOUR CLOCK FROM	926	915	900
	TO	1525	1530	1517
PST	STATIC PRESSURE OF STACK GAS, IN. HG.	0.05	0.05	0.05
PS	STACK GAS ABS. PRESSURE, IN. HG	28.81	28.82	28.97
VS	STACK GAS VELOCITY AT STACK CONDITIONS, FPM	3635	3645	3764
AS	STACK AREA, SQ. IN.	16277.	16277.	16277.
QS	STACK GAS VOLUMETRIC FLOW RATE AT NORMAL CONDITIONS, NCFM (DRY)	227230	234272	251373
QA	STACK GAS VOLUMETRIC FLOW RATE AT STACK CONDITIONS, ACFM (WET)	410867	412009	425425
I	ISOKINETIC RATE, PERCENT	110.3	106.8	104.9
MF	PARTICULATE MASS--PROBE, CYCLONE, AND FILTER, MG	9980.1	0.0	6273.8
CAN	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/NCF (DRY)	1.066	0.000	0.637
CAT	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/ACF (WET)	0.589	0.000	0.376
CAN3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/NCF (DRY)	1.129	0.000	0.691
CAT3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/ACF (WET)	0.624	0.000	0.408
CAW	PARTICULATE EMISSIONS--PROBE, CYCLONE AND FILTER, LB/HR	2074.99	0.00	1372.17

ILES BOILER, ESP INLET, LOCATION 4

RUN NO.	4	5	6
TEST DATE	7/29	7/30	7/31
'OLUME OF GAS SAMPLED, NCF (DRY)	144.2	144.0	151.7
IOISTURE FRACTION VOLUME, PERCENT	12.3	9.3	7.9
ıVERAGE STACK TEMPERATURE, F	292	296	282
;TACK VOLUMETRIC FLOW RATE, NCFM (DRY)	227230	234272	251373
;TACK VOLUMETRIC FLOW RATE, ACFM (WET)	410867	412009	425425
ISOKINETIC RATE, PERCENT	110.3	106.8	104.9
EXCESS AIR, PERCENT	22.9	23.6	25.8
PARTICULATE MASS - PROBE,CYC,FILTER CATCH, MG	9980.1	0.0	6273.8
PARTICULATE LOADING, GR/NCF AT STACK O2 (DRY)	1.066	0.000	0.637
PARTICULATE LOADING, GR/ACF AT STACK O2 (WET)	0.589	0.000	0.376
PARTICULATE LOADING, GR/NCF AT 3% O2 (DRY)	1.129	0.000	0.691
PARTICULATE LOADING, GR/ACF AT 3% O2 (WET)	0.624	0.000	0.408
PARTICULATE EMISSIONS, LB/HR	2075.0	0.0	1372.2

NILES BOILER, ESP INLET, LOCATION 4

RUN NO.	4	5	6
TEST DATE	7/29	7/30	7/31
VOLUME OF GAS SAMPLED, NCM	4.08	4.08	4.30
MOISTURE FRACTION VOLUME, PERCENT	12.3	9.3	7.9
AVERAGE STACK TEMPERATURE, C	144	146	138
STACK VOLUMETRIC FLOW RATE, NCMM	6434	6633	7118
STACK VOLUMETRIC FLOW RATE, CMM	11634	11666	12046
ISOKINETIC RATE, PERCENT	110.3	106.8	104.9
EXCESS AIR, PERCENT	22.9	23.6	25.8
PARTICULATE MASS - PROBE,CYC,FILTER CATCH,			
MG	9980.1	0.0	6273.8
PARTICULATE LOADING, MG/NCM AT STACK O2 (DRY)	2438.4	0.0	1457.6
PARTICULATE LOADING, MG/CM AT STACK O2 (WET)	1348.5	0.0	861.2
PARTICULATE LOADING, MG/NCM AT 3% O2 (DRY)	2582.7	0.0	1581.3
PARTICULATE LOADING, MG/CM AT 3% 02 (WET)	1428.3	0.0	934.3
PARTICULATE EMISSIONS, KG/HR	941.2	0.0	622.4

NILES BOILER, STACK, LOCATION 5A, MULTI-METALS TRAIN

	RUN NO.	1	2	3
	TEST DATE	7/27	7/29	7/31
	SAMPLING TIME, 24 HOUR CLOCK FROM	954	900	905
	TO	1619	1529	1542
DN	SAMPLING NOZZLE DIAMETER, IN.	0.228	0.228	0.228
TT	NET TIME OF TEST, MIN.	360	360	360
PB	BAROMETRIC PRESSURE, IN. HG	29.00	28.88	29.06
PM	AVG. ORIFICE PRESSURE DROP, IN. H2O	1.83	1.87	1.81
VM	VOLUME OF DRY GAS SAMPLED AT METER CONDITIONS, CF (DRY)	276.2	281.4	277.5
TM	AVG. GAS METER TEMPERATURE, F	107	99	97
VMSTD	VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS, NCF (DRY)	232.0	238.9	237.9
VW	TOTAL H2O COLLECTED IN IMPINGERS AND SILICA GEL, ML	536.4	564.7	559.0
VWGAS	VOLUME OF H2O VAPOR COLLECTED,NCF	23.6	24.8	24.6
M	MOISTURE IN STACK GAS BY VOLUME, PERCENT	9.23	9.41	9.36
MD	MOLECULAR FRACTION OF DRY GAS	0.91	0.91	0.91
CO2	STACK GAS C02, VOL PERCENT DRY	13.0	12.6	12.6
O2	STACK GAS O2, VOL PERCENT DRY	6.0	6.5	6.5
CO	STACK GAS CO, VOL PERCENT DRY	0.0	0.0	0.0
N2	STACK GAS N2, VOL PERCENT DRY	81.0	80.9	80.9
EA	STACK GAS EXCESS AIR, PERCENT	39.0	43.7	43.7
MWD	MOLECULAR WEIGHT OF STACK GAS, DRY BASIS	30.3	30.3	30.3
MW	MOLECULAR WEIGHT OF STACK GAS, WET BASIS	29.2	29.1	29.1
CP	PITOT TUBE COEFFICIENT	0.84	0.84	0.84
TS	AVG. STACK TEMPERATURE, F	294	293	291
NP	NET SAMPLING POINTS	4	4	4

NILES BOILER, STACK, LOCATION 5A, MULTI-METALS TRAIN

	RUN NO.	1	2	3
	TEST DATE	7/27	7/29	7/31
	SAMPLING TIME, 24 HOUR CLOCK FROM	954	900	905
	TO	1619	1529	1542
PST	STATIC PRESSURE OF STACK GAS, IN. HG.	-0.07	-0.08	-0.08
PS	STACK GAS ABS. PRESSURE, IN. HG	28.93	28.80	28.98
VS	STACK GAS VELOCITY AT STACK CONDITIONS, FPM	4146	4131	4110
AS	STACK AREA, SQ. IN.	13685.	13685.	13685.
QS	STACK GAS VOLUMETRIC FLOW RATE AT NORMAL CONDITIONS, NCFM (DRY)	225544	223594	224809
QA	STACK GAS VOLUMETRIC FLOW RATE AT STACK CONDITIONS, ACFM (WET)	393984	392578	390616
I	ISOKINETIC RATE, PERCENT	95.8	99.5	98.5
MF	PARTICULATE MASS--PROBE, CYCLONE, AND FILTER, MG	237.6	105.9	186.3
CAN	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/NCF (DRY)	0.016	0.007	0.012
CAT	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/ACF (WET)	0.009	0.004	0.007
CAN3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/NCF (DRY)	0.019	0.008	0.015
CAT3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/ACF (WET)	0.011	0.005	0.009
CAW	PARTICULATE EMISSIONS--PROBE, CYCLONE AND FILTER, LB/HR	30.49	13.08	23.23

NILES BOILER, STACK, LOCATION 5A, MULTI-METALS TRAIN

RUN NO.	1	2	3
TEST DATE	7/27	7/29	7/31
VOLUME OF GAS SAMPLED, NCF (DRY)	232.0	238.9	237.9
MOISTURE FRACTION VOLUME, PERCENT	9.2	9.4	9.4
AVERAGE STACK TEMPERATURE, F	294	293	291
STACK VOLUMETRIC FLOW RATE, NCFM (DRY)	225544	223594	224809
STACK VOLUMETRIC FLOW RATE, ACFM (WET)	393984	392578	390616
ISOKINETIC RATE, PERCENT	95.8	99.5	98.5
EXCESS AIR, PERCENT	39.0	43.7	43.7
PARTICULATE MASS - PROBE,CYC,FILTER CATCH, MG	237.6	105.9	186.3
PARTICULATE LOADING, GR/NCF AT STACK O2 (DRY)	0.016	0.007	0.012
PARTICULATE LOADING, GR/ACF AT STACK O2 (WET)	0.009	0.004	0.007
PARTICULATE LOADING, GR/NCF AT 3% O2 (DRY)	0.019	0.008	0.015
PARTICULATE LOADING, GR/ACF AT 3% O2 (WET)	0.011	0.005	0.009
PARTICULATE EMISSIONS, LB/HR	30.5	13.1	23.2

LES BOILER, STACK, LOCATION 5A, MULTI-METALS TRAIN

RUN NO.	1	2	3
TEST DATE	7/27	7/29	7/31
LUME OF GAS SAMPLED, NCM	6.57	6.77	6.74
ISTURE FRACTION VOLUME, PERCENT	9.2	9.4	9.4
ERAGE STACK TEMPERATURE, C	145	145	143
ACK VOLUMETRIC FLOW RATE, NCMM	6386	6331	6365
ACK VOLUMETRIC FLOW RATE, CMM	11156	11116	11061
SOKINETIC RATE, PERCENT	95.8	99.5	98.5
XCESS AIR, PERCENT	39.0	43.7	43.7
ARTICULATE MASS - PROBE,CYC,FILTER CATCH, G	237.6	105.9	186.3
PARTICULATE LOADING, MG/NCM AT STACK O2 (DRY)	36.1	15.6	27.6
PARTICULATE LOADING, MG/CM AT STACK O2 (WET)	20.7	8.9	15.9
PARTICULATE LOADING, MG/NCM AT 3% O2 (DRY)	43.4	19.4	34.3
PARTICULATE LOADING, MG/CM AT 3% O2 (WET)	24.8	11.1	19.7
PARTICULATE EMISSIONS, KG/HR	13.8	5.9	10.5

JILES BOILER, STACK, LOCATION 5A, MODIFIED METHOD 5

	RUN NO.	1	2	3
	TEST DATE	7/26	7/28	7/30
	SAMPLING TIME, 24 HOUR CLOCK FROM	1200	900	900
	TO	1835	1539	1524
DN	SAMPLING NOZZLE DIAMETER, IN.	0.192	0.192	0.192
TT	NET TIME OF TEST, MIN.	360	360	360
PB	BAROMETRIC PRESSURE, IN. HG	29.00	28.96	28.88
PM	AVG. ORIFICE PRESSURE DROP, IN. H2O	0.87	0.89	0.85
VM	VOLUME OF DRY GAS SAMPLED AT METER CONDITIONS, CF (DRY)	191.9	190.4	190.0
TM	AVG. GAS METER TEMPERATURE, F	122	125	104
VMSTD	VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS, NCF (DRY)	160.0	157.7	162.8
VW	TOTAL H2O COLLECTED IN IMPINGERS AND SILICA GEL, ML	368.2	356.8	340.8
VWGAS	VOLUME OF H2O VAPOR COLLECTED,NCF	16.2	15.7	15.0
M	MOISTURE IN STACK GAS BY VOLUME, PERCENT	9.19	9.05	8.43
MD	MOLECULAR FRACTION OF DRY GAS	0.91	0.91	0.92
CO2	STACK GAS C02, VOL PERCENT DRY	11.7	12.2	13.0
O2	STACK GAS O2, VOL PERCENT DRY	7.5	7.0	6.0
CO	STACK GAS CO, VOL PERCENT DRY	0.0	0.0	0.0
N2	STACK GAS N2, VOL PERCENT DRY	80.8	80.8	81.0
EA	STACK GAS EXCESS AIR, PERCENT	54.2	48.8	39.0
MWD	MOLECULAR WEIGHT OF STACK GAS, DRY BASIS	30.2	30.2	30.3
MW	MOLECULAR WEIGHT OF STACK GAS, WET BASIS	29.1	29.1	29.3
CP	PITOT TUBE COEFFICIENT	0.84	0.84	0.84
TS	AVG. STACK TEMPERATURE, F	294	292	286
NP	NET SAMPLING POINTS	4	4	4

NILES BOILER, STACK, LOCATION 5A, MODIFIED METHOD 5

			1	2	3
	RUN NO.		1	2	3
	TEST DATE		7/26	7/28	7/30
	SAMPLING TIME, 24 HOUR CLOCK	FROM	1200	900	900
		TO	1835	1539	1524
PST	STATIC PRESSURE OF STACK GAS, IN. HG.		-0.74	-0.09	-0.09
PS	STACK GAS ABS. PRESSURE, IN. HG		28.26	28.87	28.79
VS	STACK GAS VELOCITY AT STACK CONDITIONS, FPM		4225	4200	4127
AS	STACK AREA, SQ. IN.		13685.	13685.	13685.
QS	STACK GAS VOLUMETRIC FLOW RATE AT NORMAL CONDITIONS, NCFM (DRY)		224700	229124	227935
QA	STACK GAS VOLUMETRIC FLOW RATE AT STACK CONDITIONS, ACFM (WET)		401523	399139	392189
I	ISOKINETIC RATE, PERCENT		93.5	90.4	93.8
MF	PARTICULATE MASS--PROBE, CYCLONE, AND FILTER, MG		0.0	0.0	0.0
CAN	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/NCF (DRY)		0.000	0.000	0.000
CAT	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/ACF (WET)		0.000	0.000	0.000
CAN3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/NCF (DRY)		0.000	0.000	0.000
CAT3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/ACF (WET)		0.000	0.000	0.000
CAW	PARTICULATE EMISSIONS--PROBE, CYCLONE AND FILTER, LB/HR		0.00	0.00	0.00

NILES BOILER, STACK, LOCATION 5A, MODIFIED METHOD 5

RUN NO.	1	2	3
TEST DATE	7/26	7/28	7/30
VOLUME OF GAS SAMPLED, NCF (DRY)	160.0	157.7	162.8
MOISTURE FRACTION VOLUME, PERCENT	9.2	9.1	8.4
AVERAGE STACK TEMPERATURE, F	294	292	286
STACK VOLUMETRIC FLOW RATE, NCFM (DRY)	224700	229124	227935
STACK VOLUMETRIC FLOW RATE, ACFM (WET)	401523	399139	392189
ISOKINETIC RATE, PERCENT	93.5	90.4	93.8
EXCESS AIR, PERCENT	54.2	48.8	39.0
PARTICULATE MASS - PROBE,CYC,FILTER CATCH, MG	0.0	0.0	0.0
PARTICULATE LOADING, GR/NCF AT STACK O2 (DRY)	0.000	0.000	0.000
PARTICULATE LOADING, GR/ACF AT STACK O2 (WET)	0.000	0.000	0.000
PARTICULATE LOADING, GR/NCF AT 3% O2 (DRY)	0.000	0.000	0.000
PARTICULATE LOADING, GR/ACF AT 3% O2 (WET)	0.000	0.000	0.000
PARTICULATE EMISSIONS, LB/HR	0.0	0.0	0.0

NILES BOILER, STACK, LOCATION 5A, MODIFIED METHOD 5

RUN NO.	1	2	3
TEST DATE	7/26	7/28	7/30
VOLUME OF GAS SAMPLED, NCM	4.53	4.47	4.61
MOISTURE FRACTION VOLUME, PERCENT	9.2	9.1	8.4
AVERAGE STACK TEMPERATURE, C	145	144	141
STACK VOLUMETRIC FLOW RATE, NCMM	6362	6488	6454
STACK VOLUMETRIC FLOW RATE, CMM	11369	11302	11105
ISOKINETIC RATE, PERCENT	93.5	90.4	93.8
EXCESS AIR, PERCENT	54.2	48.8	39.0
PARTICULATE MASS - PROBE,CYC,FILTER CATCH,			
MG	0.0	0.0	0.0
PARTICULATE LOADING, MG/NCM AT STACK O2 (DRY)	0.0	0.0	0.0
PARTICULATE LOADING, MG/CM AT STACK O2 (WET)	0.0	0.0	0.0
PARTICULATE LOADING, MG/NCM AT 3% O2 (DRY)	0.0	0.0	0.0
PARTICULATE LOADING, MG/CM AT 3% O2 (WET)	0.0	0.0	0.0
PARTICULATE EMISSIONS, KG/HR	0.0	0.0	0.0

APPENDIX E

QA/QC

QA/QC

E-1. Sampling Completeness

The goal for data completeness in this study was defined in the QAPP as at least 85 percent. One aspect of achieving this goal is the completeness of sampling activities. Table E-1 shows the percent completeness of sampling of flue gas, solid and liquid streams at Niles Boiler No. 2. Footnotes to the table identify the causes of any incomplete sampling efforts; any such deviations from plan are also discussed in section 3.2.4 of this report.

Table E-1 shows that flue gas sampling was 100 percent complete. This completeness value excludes the PSDS filters from Location 5b, which contained insufficient sample for carbon/radionuclide analyses. However, carbon/radionuclide data in the stack were obtained at the co-located sampling Location 5a. Solid and liquid sample collection was complete.

The ESP ash and air heater ash sample collections are indicated in Table E-1 as 100 percent complete, and that was the case in that all achievable samples were collected. However, in some collection periods samples could not be collected from individual hoppers. These occurrences have been noted as deviations from the sampling plan, in Section 3.2.4 of this report.

TABLE E-1. COMPLETENESS OF SAMPLE COLLECTION AT NILES BOILER NO. 2

Type of Sample	Completeness (percent)
Flue Gas	
Multi-Metals (Method 29)	100
Modified Method 5 (Method 23)	100
Particulate Mass (Locations 4b, 5b)	100
HEST Sampler	100
Canisters (VOC)	100
VOST (VOC)	100
TO-5 (Aldehydes)	100
Method 26A (Anions)	100
APHA 401 (Ammonia)	100
APHA 808 (Cyanide)	100
Filter Carbon[a]	100
Filter Radionuclides[a]	100
Particle Size Distribution	
Impactors	100
Cyclones	100
Solid Samples	
Boiler Feed Coal	100
Bottom Ash	100
Air Heater Ash	100
ESP Ash	100
Liquid Samples	
River Water	100
Pond Water	100
Coal Pile Runoff	100

(a) Locations 4, 5a only; 5b PSDS filters too lightly loaded for analysis.

E-2. Analytical

E-2.1 Elements (ICP)

Accuracy, precision, and completeness for elemental analysis conducted by CTE are provided in Table E-2. Accuracy was determined by evaluating the recovery of a known amount of a standard solution spiked into a digested sample. Precision was determined by evaluating the relative percent difference of duplicate instrument analyses of a single digested sample. A completeness of 100 percent was achieved for ICP analysis of elements.

Method detection limits (DL) for elements in gas samples were calculated using the following equation:

$$DL\ (\mu g/dscm) = Instrument\ Detection\ Limit\ (\mu g/mL)\ x\ \frac{Digested\ Sample\ Volume\ (mL)}{Gas\ Sample\ Volume\ (dscm)}$$

The instrument detection limit in the above equation is determined by calculating three times the standard deviation of background emission.

For example, the detection limit for cadmium in the filter from N-5a-MUM-727 was calculated as follows:

$$DL = 0.005\ \mu g/mL\ x\ \frac{150\ mL}{0.3759\ g} = 2\ \mu g/g$$

This detection limit in μg/g units was then converted to units of μg/dscm as follows:

$$DL = 2\ \mu g/g\ x\ \frac{0.3759\ g}{7.071\ dscm} = 0.11\ \mu g/dscm$$

TABLE E-2. ACCURACY, PRECISION, AND COMPLETENESS FOR ELEMENT ANALYSIS

Analyte Compounds	Accuracy How Measured	Accuracy Target (%)	Accuracy Actual (%)[a]	Precision How Measured	Precision Target (%)	Precision Actual (%)[a]	Completeness (%)
LIQUID	Spike Recovery	75-125		RPD of Duplicate Analysis	<20		100
Aluminum			84, 95			1.4, 18	
Antimony			85-105			1, 14	
Arsenic			85-113			0-17	
Boron			NA			NA[d]	
Barium			43-101			2.7, 3.1	
Beryllium			106-110			ND[c]	
Cadmium			99-102			ND	
Cobalt			95-99			ND	
Chromium			101-103			ND	
Copper			85-102			ND, 25	
Potassium			82-100			3.8, 11	
Lead			103-120			2-14	
Manganese			90-102			ND, 8.2	
Mercury			106			0-17	
Molybdenum			98-111			ND	
Sodium			115[b]			10, 16	
Selenium			73-114			4, 13	
Nickel			98-109			ND	
Silicon			NA			NA	
Titanium			101-104			9.5, 17	
Vanadium			102-106			ND	
SOLID	Spike Recovery	75-125		RPD of Duplicate Analysis	<20		100
Antimony			80-95			6-11	
Arsenic			78-105			6-10	
Aluminum			NA			1.9-19	
Barium			13-131			0.2-11	
Boron			NA			NA	
Beryllium			94-102			7.4-8.7	
Cadmium			94-101			ND	
Cobalt			95-104			10-30	
Chromium			95-103			1.8-10.3	
Copper			84-98			2.2-123	
Potassium			71-94			3.2-12	
Lead			97-111			4, 4	
Manganese			91-104			0.6-7.9	
Mercury			88-112[e]			NA	
Molybdenum			92-103			ND	

TABLE E-2. (Continued)

Analyte Compounds	Accuracy How Measured	Accuracy Target (%)	Accuracy Actual (%)[a]	Precision How Measured	Precision Target (%)	Precision Actual (%)[a]	Completeness (%)
Selenium			79-99			1	
Sodium			-45-230			3.1-25	
Nickel			94-105			9.1-19.9	
Silicon			NA			NA	
Titanium			25-100			3.1-7.8	
Vanadium			94-100			3.6-8	
GAS	Spike Recovery	75-125		RPD of Duplicate Analysis	<20		100
Antimony			83-119			1-17	
Arsenic			76-115			1-21	
Aluminum			45-127			1.1-4.6	
Barium			87-104			2.4-7.9	
Beryllium			72-108			0-2.2	
Boron			NA			NA	
Cadmium			76-147			ND	
Chromium			87-143			2-8	
Cobalt			81-130[f]			0-18	
Copper			78-114			0-4.4	
Lead			85-109			1-10	
Manganese			89-136			1.8-3.5	
Mercury			80-144			0-36	
Molybdenum			97-144			ND	
Nickel			61-122			0.6-32	
Potassium			26-104			1.8-200	
Selenium			75-117			1-14	
Silicon			NA			NA	
Sodium			35-93			1.3-10	
Titanium			29-102			0-2.2	
Vanadium			86-114			ND-2.6	

(a) Except where indicated, range represents range of results for multiple samples, two numbers separated by a comma represents results for two samples, and single number represents results for single sample or determination.
(b) Excludes outlier of 12 percent recovery.
(c) ND = Analyte not detected in sample therefore RPD could not be calculated.
(d) NA = Data not available or analysis not conducted.
(e) Recovery from standard reference material.
(f) Excludes outlier of 12 percent recovery.

E-2.2 Mercury

Accuracy, precision, and completeness results for CVAA analysis of mercury in gas impinger samples conducted by Battelle are presented in Table E-3. Accuracy was determined by evaluating the recovery of mercury spiked into digested sample matrix. Precision was determined by calculating the relative percent difference of duplicate instrument analyses of a single sample. Accuracy and precision obtained met the target objectives in all cases. A completeness of 100 percent was obtained for all mercury analyses.

TABLE E-3. ACCURACY, PRECISION, AND COMPLETENESS FOR MERCURY ANALYSIS[a]

	Accuracy			Precision			
Analyte/Surrogate Compounds	How Measured	Target (%)	Actual (%)[b]	How Measured	Target (%)	Actual (%)[b]	Completeness
Mercury	Spike Recovery	75-125	92-108	RPD of Duplicate Analysis	<20	0-5	100

(a) Represents results from analysis of gas samples only.

(b) Except where indicated, range represents range of results for multiple samples, two numbers separated by a comma represents results for two samples, and single number represents results for single sample or determination.

E-2.3 Ammonia/Cyanide

A summary of the accuracy, precision, and completeness obtained for the ammonia/cyanide analysis of the gas and liquid samples is provided in Table E-4. Accuracy was determined by calculating the recovery of a known amount of analyte spiked into a sample. Precision was determined by duplicate instrument analysis of a single sample. The accuracy and precision obtained met the target quality objectives in all cases, except for the precision associated with the duplicate analysis of a sample containing ammonia at a level less than the detection limit. A completeness of 100 percent was achieved for all samples.

The method detection limits for ammonia and cyanide in gas samples were determined as follows:

$$DL\ (\mu g/dscm) = \frac{Instrument\ Detection\ Limit\ (\mu g/sample)\ *}{Gas\ Sample\ Volume\ (dscm)}$$

For example, the detection limit for ammonia in N-5a-NH_4-727 was calculated as follows:

$$DL = \frac{0.4\ \mu g/sample}{0.450238\ dscm} = 0.89\ \mu g/dscm$$

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* Calculated from three times the standard deviation for replicate analysis of low-level samples.

TABLE E-4. ACCURACY, PRECISION, AND COMPLETENESS FOR AMMONIA AND CYANIDE ANALYSIS OF GAS AND LIQUID SAMPLES

	Accuracy			Precision			
Analyte/Surrogate Compounds	How Measured	Target (%)	Actual (%)[a]	How Measured	Target (%)	Actual (%)[a]	Analytical Completeness (%)
GAS	Spike Recovery			RPD of Duplicate Analysis			
Ammonia		75-125	100-104		<20	0-12[b]	100
Cyanide		75-125	85-105		<20	2,2	100
LIQUID							
Ammonia		75-125	102-104		<20	2-17	100
Cyanide		75-125	84-94		<20	1,6	100

(a) Except where indicated, range represents range of results for multiple samples, two numbers separated by a comma represents results for two samples, and single number represents results for single sample or determination.

(b) RPD results of 12 at 0.078 and 0.088 μgN/mL level (0.094 and 0.106 μg NH_3/mL).

E-2.4 Anions

Accuracy, precision, and completeness results for anion analysis are presented in Table E-5. Accuracy was determined by evaluating the recovery of target analytes spiked into sample matrix as well as analysis of a standard reference material (SRM). Precision was determined by calculating the relative percent difference of duplicate analysis of a single sample. Accuracy and precision obtained met the target objectives in all cases. A completeness of 100 percent was obtained for all anion analyses.

Detection limits for anion analyses of gas samples by ion chromatography were determined by the observation of a calibration standard which when analyzed provided an approximate 3:1 signal-to-noise ratio.

Species which interfered with the chromatographical analysis of a sample, i.e. a species which overloaded the column or eluted near the retention window of interest, were corrected for by sample dilution which in turn required a proportional increase in the detection limit for the sample. The method detection limit is calculated as follows:

$$DL\ (\mu g/dscm) = \text{Lowest Level Calibration Std } (\mu g/mL) \times \text{Sample Dilution Factor} \times \text{Extraction Volume (mL)/Gas Sample Volume (dscm)}$$

For example, in the analysis of phosphate in Niles filter sample N-5a-FCL-725, matrix interference in the sample required a dilution of 1:2 to improve the overall chromatography and minimize fouling of the column. The detection limit for the sample was then determined as follows:

$$0.050\ \mu g/mL \times 2 \times 20\ mL/1.4\ dscm = 1.4\ \mu g/dscm$$

TABLE E-5. ACCURACY, PRECISION, AND COMPLETENESS FOR ANION ANALYSIS

	Accuracy			Precision			
Analyte/Surrogate Compounds	How Measured	Target (%)	Actual (%)	How Measured	Target (%)	Actual (%)	Completeness
<u>Gas (Impinger Solution)</u>	Spike Recovery			RPD of Duplicate Analysis			100
Chloride		75-125	NA		<20	9.4	
Fluoride		75-125	NA		<20	0.7,5.7	
	SRM Analysis						
Chloride		143-171 ppm	154,154 ppm				
Fluoride		1.55-2.02 ppm	1.84-1.92 ppm				
<u>Gas (Filter)</u>	Spike Recovery			RPD of Duplicate Analysis			100
Chloride		75-125	98,125		<20	1.2,15	
Fluoride		75-125	99-108		<20	0.1,1.3	
Sulfate		75-125	100		<20	0.9,0.2	
Phosphate		75-125	114		<20	1.1	
	SRM Analysis						
Chloride		143-171 ppm	161,166 ppm				
Fluoride		1.55-2.02 ppm	1.72-1.96 ppm				
Sulfate		70.1-93.9 ppm	83.8,88.8 ppm				
Phosphate		0.555-0.779 ppm	0.589 ppm				
<u>Solids/Liquids</u>	Spike Recovery			RPD of Duplicate Analysis			100
Chloride		75-125	95		<20	4.6,14	
Fluoride		75-125	106,111		<20	105	
Sulfate		75-125	86		<20	0.47-3.1,45	
Phosphate		75-125	78-113		<20	0.0	
	SRM Analysis						
Chloride		143-171 ppm	155-175 ppm				
Fluoride		1.55-2.02 ppm	1.62-1.77 ppm				
Sulfate		70.1-93.9 ppm	76.5-84.4 ppm				
Phosphate		0.555-0.779 ppm	0.648-0.730 ppm				

NA = not analyzed or data not available.

E-2.5 VOC

E-2.5.1 Gas Samples (VOST)

A summary of the accuracy, precision, and completeness obtained for analysis of VOC in VOST samples is shown in Table E-6. To determine accuracy, each sample was spiked with four surrogate compounds prior to analysis. Recovery of the surrogate spike was then considered as the analytical accuracy. As shown, the surrogate spike recovery met the original objectives of 26-160 percent. Sample N-5A-VOS-730-2 was lost during analysis so a completeness of 96 percent (26 samples reported/27 samples received) was achieved.

A method detection limit of 25 ng/sample was determined by calculating ten times the standard deviation of replicate analyses of a 50 ng standard. Detection limits for individual samples were then calculated by dividing 25 ng/sample by the associated gas sample volume.

TABLE E-6. ACCURACY, PRECISION, AND COMPLETENESS FOR VOC VOST ANALYSIS

Analyte/Spike Compounds	Accuracy: How Measured	Accuracy: Target (%)	Accuracy: Actual (%)	Precision: How Measured	Precision: Target (%)	Precision: Actual (%)	Completeness
	Surrogate Spike Recovery						96
d_4-1,2-Dichloroethane		26-160	42-128		<20	NA	
d_8-Toluene		26-160	63-164, 503[a]		<20	NA	
d_6-Benzene		26-160	77-139		<20	NA	
p-Bromofluorobenzene		26-160	26-112		<20	NA	

(a) Interference in sample may have contributed to high percent recovery.

E-2.5.2 Gas Samples (Canister)

A summary of the precision, accuracy and completeness obtained for analysis of VOC in canister samples is shown in Table E-7. Information on accuracy was obtained from a canister spiked with four target compounds. The concentrations of the four components were established by reference to the 41 component calibration cylinder. This cylinder has been recently audited by US EPA and shown to be within $\pm$ 10 percent of the stated values for 15 compounds common to both mixtures. The contents of the spiked canister were directed through the sampling train and into a second canister. Both canisters were analyzed to determined the amount recovered. Analytical precision was determined by repeated analyses (3 times) of a 1/100 dilution mixture from the 41 component calibration cylinder. The four components used during the field spike experiment are reported. A completeness of 100 percent was achieved for canister analyses.

Detection limits for VOC in canister samples were calculated as follows:

$$DL\ (ppb) = \frac{Concentration\ of\ Stds\ (ppb)}{Average\ of\ Range\ of\ Std\ Peak\ Areas\ (all)} \ x\ 3 \times (Peak\ Area\ Noise)$$

The calibration cylinder contained the 41 target components each at a nominal concentration of 200 ppb. The cylinder was dynamically diluted to the 6 ppb level. Using the selective ion monitoring mode of the GC/MS, area counts from 850,000 to 1,700,000 were obtained for the target compounds. The peak area noise was approximately 35,000 area units. No changes in electron multiplier gain was made during the study so the above responses hold throughout the time period. With these results, the actual detection limit achieved was calculated as follows:

$$DL\ (ppb) = \frac{6\ ppb}{((1{,}700{,}000 + 850{,}000)/2)} \ x\ 3\ (35{,}000) = 0.5\ ppb$$

The detection limit in ppb units was then converted to μg/dscm units by multiplying by a conversion factor. For example, 1 ppb of trichlorofluoromethane at 0°C and 760 mm is equal to 6.11 μg/dscm; therefore the converted detection limit was 3.06 μg/dscm.

TABLE E-7. ACCURACY, PRECISION, AND COMPLETENESS FOR VOC CANISTER ANALYSES

Analyte/Spike Compounds	Accuracy: How Measured	Accuracy: Target (%)	Accuracy: Actual (%)	Precision: How Measured	Precision: Target (%)	Precision: Actual (%)	Completeness (%)
	Spike of Sampling Train with Canister			RSD of Replicate Analysis of Standard Cylinder			100
Benzene	25.6 $\mu g/m^3$	75-125	108		< 20	± 24	
Toluene	23.0 $\mu g/m^3$	75-125	122		< 20	± 13	
Ethylbenzene	25.6 $\mu g/m^3$	75-125	109		< 20	± 12	
Styrene	19.2 $\mu g/m^3$	75-125	102		< 20	± 12	

E-2.5.3 Liquid Samples

QA/QC results for the analysis of VOC in liquid samples are presented in Table E-8.

Each sample was spiked with three surrogate compounds prior to analysis. All of the samples fell outside of surrogate recovery limits (all over-recovered) except N-9-PRL-730, the trip blank and field blank. All of the samples were re-analyzed except for N-9-PRL-730 MS and MSD. Re-analysis of samples N-9-PRL-726, N-9-PRL-726 MS (matrix spike), N-9-PRL-726 MSD (matrix spike duplicate), N-10-PRL-726 were still outside surrogate recovery limits. Generally this indicates a matrix interference is present.

Two matrix spikes and matrix spike duplicates were analyzed and one MS/MSD pair was re-analyzed. The Relative Percent Difference (RPD) for nearly all of the spiked compounds was within the target range of ± 25 percent.

Limits for surrogate recoveries as they appear in Table E-8 were taken directly from Method 8240. Limits for spike recoveries as they appear in Table E-8 were taken from Method 8240 QC Acceptance Criteria Table.

TABLE E-8. ACCURACY, PRECISION, AND COMPLETENESS FOR VOC ANALYSIS OF LIQUID SAMPLES

	Accuracy			Precision			
Analyte/Surrogate Compounds	How Measured	Target (%)	Actual (%)	How Measured	Target (%)	Actual (%)	Completeness
	Surrogate Spike Recovery						100
1,2-Dichloroethane-d_4		76-114	92-159[b]	RPD of Matrix Spike/ Matrix Spike Duplicate	NA[a]	NA	
Toluene-d_8		88-110	89-157[b]		NA	NA	
4-Bromofluorobenzene		86-115	89-164[b]		NA	NA	
	Matrix Spike Recovery						100
Benzene		37-151	141-173		25	2-8	
Bromomethane		D-242	70-146		25	2-43	
Bromoform		45-169	95-170		25	7-13	
Carbon tetrachloride		70-140	103-110		25	3-19	
Chlorobenzene		37-160	96-126		25	6-23	
Chloromethane		D-273	78-112		25	12-19	
1,1-Dichloroethane		59-155	80-123		25	4-31	
1,2-Dichloroethane		49-155	100-143		25	3-17	
cis-1,3-Dichloropropylene		D-227	96-158		25	1-12	
trans-1,3-Dichloropropylene		17-183	117-154		25	2-12	
Ethylbenzene		37-162	137-162		25	3-12	
Methylene chloride		D-221	74-99		25	5-36	
Toluene		47-150	127-177		25	0.3-5	
1,1,1-Trichloroethane		52-162	83-140		25	3-40	
1,1,2-Trichloroethane		52-150	95-181		25	1-19	
Trichloroethylene		71-157	90-129		25	2-7	
Vinyl chloride		D-251	76-84		25	5-30	

D = detected.

(a) NA = not available.

(b) All samples exceeding target range were reanalyzed.

E-2.6 PAH/SVOC

E-2.6.1 Gas and Solid Samples

Accuracy, precision, and completeness results for PAH/SVOC analysis of gas and solid samples are presented in Table E-9. Accuracy was determined by recovery of perdeuterated PAH spike compounds added to the samples prior to extraction. In most cases, spike recoveries met the target objective of 50 to 150 percent. Precision was determined by evaluating the relative standard deviation of calibration standard analyses. The average RSD for three calibration standards, 0.05 ng/μL, 0.1 ng/μL, and 0.5 ng/μL is presented in Table E-9. As shown, this average RSD is below the target 30 percent in all cases. Individual RSD for these three standards were also below the 30 percent target. A completeness of 100 percent was achieved for the gas and solid samples.

The estimated detection limit for PAH is 0.01 ng on column and for SVOC is 0.05 ng on column with a 1-μL injection. At these concentration levels, the signal-to-noise ratio is about 3. The detection limit for PAH/SVOC was calculated using the following equation:

$$DL = \frac{\textit{Estimated Detection Limit Concentration x Final Volume of Extract Analyzed}}{\textit{Gas Sample Volume} \quad x \quad \textit{Fraction of Extract Analyzed}}$$

For example, the detection limit for hexachloroethane in N-4-MM5-X-726 was calculated as follows:

$$\frac{0.05 \ ng/\mu L \ x \ 1000 \ \mu L}{6.5317 \ dscm \ x \ 1.0} = 7.7 \ ng/dscm$$

TABLE E-9. ACCURACY, PRECISION, AND COMPLETENESS FOR PAH/SVOC ANALYSIS OF GAS AND SOLID SAMPLES

	Accuracy			Precision			
Analyte/Surrogate Compounds	How Measured	Target (%)	Actual (%)	How Measured	Target (%)	Actual (%)	Completeness
	Recovery of Perdeuterated PAH Spike						
GAS							100
d_{12}-Chrysene		50-150	56-125				
d_{12}-Benzo(k)fluoranthene		50-150	41-125				
SOLID							100
d_{12}-Chrysene		50-150	21-128				
d_{12}-Benzo(k)fluoranthene		50-150	30-126				
				RSD of Calibration Standard Analysis	< 30		
GAS/SOLID							
Benzylchloride						15.9	
Acetophenone						15.1	
Hexachloroethane						11.3	
Naphthalene						7.5	
Hexachlorobutadiene						11.2	
2-Chloroacetophenone						8.2	
1-Methylnaphthalene						7.4	
2-Methylnaphthalene						5.3	
Hexachlorocyclopenta-diene						12.3	
Biphenyl						6.6	
Acenaphthylene						5.2	
2,6-Dinitrotoluene						7.9	
Acenaphthene						6.4	
Dibenzofuran						6.9	
2,4-Dinitrotoluene						8.8	
Fluorene						6.1	
Hexachlorobenzene						6.5	
Pentachlorophenol						11.2	
Phenanthrene						11.6	
Anthracene						6.7	
Fluoranthene						13.2	

TABLE E-9. (Continued)

Analyte/Surrogate Compounds	Accuracy: How Measured	Accuracy: Target (%)	Accuracy: Actual (%)	Precision: How Measured	Precision: Target (%)	Precision: Actual (%)	Completeness
				RSD of Calibration Standard Analysis			
Pyrene						9.2	
Benz(a)anthracene						8.6	
Chrysene						6.0	
Benzo(b&k)fluoranthene						8.0	
Benzo(e)pyrene						7.5	
Benzo(a)pyrene						9.2	
Indeno(1,2,3-c,d)pyrene						10.5	
Dibenzo(a,h)anthracene						11.1	
Benzo(g,h,i)perylene						6.5	

E-2.6.2 Liquid Samples

Accuracy, precision, and completeness results for PAH/SVOC analysis of liquid samples are presented in Table E-10. Each sample was spiked with eight surrogate compounds prior to analysis. Two of the surrogates do not have established recovery limits. All samples were within surrogate recovery limits except sample N-9-PRL-730 Trip Blank which had 168 percent recovery for nitrobenzene-d_5 .

Two matrix spikes and matrix spike duplicates were analyzed. The Relative Percent Difference (RPD) for one set of MS/MSD's was out of the target limit of ± 25 percent. The matrix spike duplicate sample in this set exhibited lower recovery for all of the spiked compounds including the surrogates. The other matrix spike/matrix spike duplicate pair was within the RPD target of 25 percent with the exception of pentachlorophenol which had a RPD of 25.94.

Limits for surrogate recoveries as they appear in these tables were taken directly from Method 8270. Limits for spike recoveries as they appear in these tables were taken from Method 8270 QC Acceptance Criteria Table.

TABLE E-10. ACCURACY, PRECISION, AND COMPLETENESS FOR PAH/SVOC ANALYSIS OF LIQUID SAMPLES

	Accuracy			Precision			
Analyte/Surrogate Compounds	How Measured	Target (%)	Actual (%)	How Measured	Target (%)	Actual (%)	Completeness
	Surrogate Spike Recovery						100
2-Fluorophenol		21-100	26-56	NA[a]	NA	NA	
Phenol-d_5		10-94	19-41	NA	NA	NA	
2-Chlorophenol-d_4		NE[b]	39-72	NA	NA	NA	
1,2-Dichlorobenzene-d_4		NE	50-139	NA	NA	NA	
Nitrobenzene-d_5		35-114	41-168	NA	NA	NA	
2-Fluorobiphenyl		43-116	41-80	NA	NA	NA	
2,4,6-Tribromophenol		10-123	41-74	NA	NA	NA	
Terphenyl-d_{14}		33-141	39-139	NA	NA	NA	
	Matrix Spike Recovery			RPD of Matrix Spike and Matrix/ Spike Duplicate			100
Phenol		5-112	28,41		< 25	5,41	
2-Chlorophenol		23-134	55,66		< 25	3,31	
1,4-Dichlorobenzene		20-124	69,77		< 25	8,38	
1,2,4-Trichlorobenzene		44-142	99,110		< 25	12,16	
4-Chloro-3-Methylphenol		22-147	71,94		< 25	4,18	
Acenaphthene		47-145	84,94		< 25	2,39	
4-Nitrophenol		D-132	46,52		< 25	16,61	
2,4-Dinitrotoluene		39-139	92,104		< 25	15,47	
Pentachlorophenol		14-176	57,63		< 25	26,49	
Pyrene		52-115	74,81		< 25	17,28	

D = detected.

(a) NA = not available.

(b) NE = not established.

E-2.7 Dioxins/Furans

Accuracy, precision, and completeness results for dioxin/furan analysis are presented in Table E-11. Accuracy was determined by evaluating recovery of $^{13}C_{12}$-labelled internal standards spiked into the samples prior to extraction and by evaluating recovery of native dioxins/furans spiked into a matrix spike sample. In all cases except one sample for 1,2,3,4,7,8-HxCDD, recoveries of internal standards and matrix spike compounds met the accuracy objective of 40 to 120 percent. Precision was determined by calculating the relative standard deviation of internal standard recoveries obtained for samples. As shown, the precision obtained met the target objective of <25 percent in all cases.

The detection limit for dioxins/furans in gas samples was calculated using the following equation:

$$DL = \frac{\text{Sum of Noise Heights at Native Isomer Retention Time}}{\text{Sum of Peak Heights for Labeled Internal Standard}} \; x$$

$$\frac{\text{Quantity of Internal Standard}}{\text{Native Response Factor}} \; x \; \frac{2.5}{\text{Gas Sample Volume}}$$

For example, actual detection limits were calculated for 2,3,7,8-tetrachlorodibenzo-p-dioxin in N-5a-MM5-726 as follows:

$$\text{Filter } DL = \frac{(2 + 2)}{(2305 + 2808)} \; x \; \frac{2000 \; pg}{1.068} \; x \; \frac{2.5}{2.438081 \; dscm} = 1.5 \; pg/dscm$$

$$XAD \; DL = \frac{(5 + 5)}{(1669 + 2061)} \; x \; \frac{2000 \; pg}{1.068} \; x \; \frac{2.5}{2.438081 \; dscm} = 5.15 \; pg/dscm$$

The detection limit for the total sample was then calculated as the average of the filter + XAD detection limits as follows:

$$\text{N-5a-MM5-726 total detection limit} = \frac{1.50 \; pg/dscm + 5.15 \; pg/dscm}{2} = 3.33 \; pg/dscm$$

TABLE E-11. ACCURACY, PRECISION, AND COMPLETENESS FOR DIOXIN/FURAN ANALYSES

Analyte Compounds	Accuracy			Precision			Completeness (%)
	How Measured	Target (%)	Actual (%)	How Measured	Target (%) (RSD)	Actual (%) (RSD)	
	Spike Recovery			NA			100
2378-TCDD		40-120	97.1-101.2		NA	NA	
12378-PeCDD		40-120	99.5-105.2		NA	NA	
123478-HxCDD		40-120	97.8-123.3[a]		NA	NA	
123678-HxCDD		40-120	92.2-97.9		NA	NA	
123789-HxCDD		40-120	99.6-114.8		NA	NA	
1234678-HpCDD		40-120	96.1-111.3		NA	NA	
OCDD		40-120	98.8-105.3		NA	NA	
2378-TCDF		40-120	92.0-96.0		NA	NA	
12378-PeCDF		40-120	90.9-102.8		NA	NA	
23478-PeCDF		40-120	90.3-98.4		NA	NA	
123478-HxCDF		40-120	97.7-99.4		NA	NA	
123678-HxCDF		40-120	90.5-95.6		NA	NA	
123789-HxCDF		40-120	91.5-93.6		NA	NA	
234678-HxCDF		40-120	98.4-98.7		NA	NA	
1234678-HpCDF		40-120	84.5-88.5		NA	NA	
1234789-HpCDF		40-120	100.3-106.3		NA	NA	
OCDF		40-120	90.5-105.5		NA	NA	
2378-TCDD-13C12		40-120	66-94	RSD of	<25	8.7	
12378-PeCDD-13C12		40-120	55-107	Standard	<25	18.0	
123478-HxCDD-13C12		40-120	75-107		<25	9.2	
123678-HxCDD-13C12		40-120	71-95		<25	6.5	
1234678-HpCDD-13C12		40-120	61-88		<25	11.8	
OCDD-13C12		40-120	52-82		<25	12.6	
2378-TCDF-13C12		40-120	58-84		<25	9.9	
12378-PeCDF-13C12		40-120	48-89		<25	17.3	
23478-PeCDF-13C12		40-120	51-93		<25	15.6	
123478-HxCDF-13C12		40-120	65-88		<25	6.6	
123678-HxCDF-13C12		40-120	68-93		<25	7.0	
123789-HxCDF-13C12		40-120	70-92		<25	6.0	
234678-HxCDF-13C12		40-120	70-92		<25	7.9	
1234678-HpCDF-13C12		40-120	67-93		<25	9.1	
1234789-HpCDF-13C12		40-120	59-83		<25	7.6	
2378-TCDD-37CL4		40-120	81-97		<25	4.8	

NA = Not available.

(a) Outside target range.

E-2.8 Aldehydes

Accuracy, precision, and completeness results for analysis of aldehydes in gas and liquid samples are presented in Table E-12. Accuracy was determined by recovery of analytes spiked into water. As shown, except for a 179 percent recovery of formaldehyde spiked into water at or near the method detection limit, all recoveries met the target objective of 50 to 150 percent. The precision was determined by the relative standard deviation of standard analyses and also met the target objectives. Completeness of 100 percent was obtained for both gas and liquid samples.

Method detection limits for aldehydes in gas samples were calculated using the following equation:

$$DL(\mu g/dscm) = A_{\min}\ x\ \frac{C_{std}(\mu g/mL)}{A_{STD}}\ x\ \frac{V_{e-avg}(mL)}{V_{sampled}(dscm)}\ x\ \frac{MW_{neat}}{MW_{DER}}$$

where:

DL	=	Detection Limit
A_{min}	=	Minimum detectable peak area of carbonyl
A_{std}	=	Peak area of carbonyl derivative in standard solution
C_{std}	=	Concentration of carbonyl derivative in standard solution
V_{e-avg}	=	Average final volume of DNPH-acetonitrile solution
$V_{sampled}$	=	Average volume of air sampled
MW_{neat}	=	Molecular weight of neat carbonyl compound
MW_{DER}	=	Molecular weight of carbonyl derivative.

For Niles, actual detection limits were calculated as follows:

$$4300\ x\ \frac{2\ \mu g/mL}{334293}\ x\ \frac{31.7\ mL}{0.05853\ dscm}\ x\ \frac{30.03}{210} = 2\ \mu g/dscm$$

TABLE E-12. ACCURACY, PRECISION, AND COMPLETENESS FOR ALDEHYDE ANALYSES

	Accuracy			Precision			
Analyte/Spike Compounds	How Measured	Target (%)[a]	Actual (%)[a]	How Measured	Target (%)[a]	Actual (%)[a]	Completeness (%)
GAS/LIQUID	Spike Recovery			RSD of Standard Analysis			100
Formaldehyde		50-150	114-122[b]		± 15	0.45	
Acetaldehyde		50-150	85-100		± 15	0.57	
Acrolein		50-150	NA		± 15	0.32	
Propionaldehyde		50-150	81-95		± 15	0.59	
LIQUID	Spike Recovery			RSD of Standard Analysis			100
Formaldehyde		50-150	114-122[b]		± 15	0.45	
Acetaldehyde		50-150	85-100		± 15	0.57	
Acrolein		50-150	NA		± 15	0.32	
Propionaldehyde		50-150	81-95		± 15	0.59	

(a) Except where indicated, range represents range of results for multiple samples, two numbers separated by a comma represents results for two samples, and single number represents results for single sample or determination.

(b) Excludes 179 percent recovery for spike at detection limit of method.

(c) NA = Not analyzed.

E-2.9 Radionuclides

Accuracy, precision, and completeness results for radionuclide analysis are presented in Table E-13. Accuracy was determined by evaluating the recovery of cesium-137 spiked into sample matrix. Precision was determined by evaluating results of duplicate sample analyses. The precision achieved met the target objective of ± 3 standard deviations; relative percent differences (RPD) are provided in Table E-13 for comparability with other analytical data. A completeness of 100 percent was obtained for all radionuclides analyses.

The method detection limit for radionuclides was calculated using the following equation:

$$MDC = \frac{4.65\sqrt{BKG} + 2.71}{(2.22)(EFF)(AVOL)(CTIME)(Ab)(D)}$$

where:

MDC	=	Minimal detectable concentration
BKG	=	Background counts
EFF	=	Counting efficiency
AVOL	=	Aliquot volume (g or L)
CTIME	=	Count time (min)
Ab	=	Abundance of emission
D	=	Decay correction
2.22	=	Conversion from dpm to pCi
4.65, 2.71	=	Constants.

This equation is derived from the following reference:

"Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements", L. A. Currie, NUREG/CR-4007, U.S. Nuclear Regulatory Commission, September 1984.

TABLE E-13. ACCURACY, PRECISION, AND COMPLETENESS FOR RADIONUCLIDE ANALYSIS

	Accuracy			Precision			
Analyte/Surrogate Compounds	How Measured	Target (%)	Actual (%)	How Measured	Target (%)	Actual (%)	Completeness
	Spike Recovery			RPD of Duplicate Analysis[b]			100
Cs-137		NA	100-109				
Pb-210					--	5	
Pb-212					--	14	
Ra-226					--	1	
Ra-228					--	20	
Th-234					--	10	
U-234					--	49	
U-235					--	33	

(a) Precision not provided for radionuclides not detected in both sample and duplicate.

(b) All duplicate results agreed to with ± 3 standard deviations target objective; RPD provided for comparability with other analytical data.

NA = Not available.

E-3. Method Detection Limit

Approximate emission detection limits obtained for gas samples in which analytes were not detected are listed in Table E-14.

TABLE E-14. EMISSION DETECTION LIMITS

	Actual Emission Detection Limit (μg/dscm)[a]	Target Emission Detection Limit (μg/dscm)
Element		
Mo	NC	1.5
B	NC	1.2
Sb	0.7	0.3
As	NC	0.06
Ba	NC	0.3
Be	NC	0.3
Cd	0.2	0.3
Cr	NC	1.2
Pb	NC	0.06
Mn	NC	0.3
Hg	0.02	0.03
Ni	NC	1.2
Se	NC	0.12
V	NC	0.6
Cu	NC	0.6
Co	0.3	0.9
Ammonia	1	750
Cyanide	NC	191
Anions		
F^-	NC	3
Cl^-	NC	3
$PO_4^{\equiv}$	30	30
$SO_4^{=}$	NC	7.5
PAH/SVOC	0.4-20	0.1-10 ng/dscm[b]
Dioxins/Furans		
TCDD/TCDF	0.003	0.03 ng/dscm
PeCDD/PeCDF	0.005	0.053 ng/dscm
HxCDD/HxCDF	0.005	0.053 ng/dscm
HpCDD/HpCDF	0.005	0.053 ng/dscm
OCDD/OCDF	NC	0.08 ng/dscm
Aldehydes	2	2
VOC - Canister	4	6
VOC - VOST	6	1.3-7.5

(a) Approximate emission detection limit obtained in sample analyses. Values for PAH/SVOC and dioxins/furans are in ng/dscm.

(b) Calculated target emission detection limit will range from 0.1 to 10 ng/dscm depending upon SVOC compound and matrix.

NC = Not calculated since analyte concentration above method detection limits in samples.

APPENDIX F

ANALYTICAL PROTOCOL

F-1. Element Analytical Protocols

Elements in flue gas, solid, and liquid samples were analyzed by various methods (ICP, GFAA, CVAA) according to the procedures described in the QAPP. Specific deviations from those procedures were as follows:

(1) *Samples sent to CTE for analysis instead of Battelle.* In order to meet the reporting deadline, it was necessary to send process solid, process liquid, PSDS filter, and gas samples (excluding impinger samples for mercury analysis) to Commercial Testing and Engineering Company (CTE) in Denver, Colorado for analysis. CTE followed the Quality Assurance Plan for element determinations with the following exceptions:

- The analyses of solid samples by CTE for mercury were accomplished by a double gold film amalgamation CVAA technique. No spike samples were performed due to the use of a solid sample matrix. However, recoveries for solid reference materials were within the limits established for this program.

- Silicon, aluminum, titanium, potassium, and sodium in solid samples (boiler feed coal, bottom ash, air heater ash, and ESP ash) were determined by X-ray fluorescence spectroscopy, in accordance with ASTM D4326, instead of ICP.

(2) The H_2O_2 reagent blank was lost during sample preparation. A water reagent blank was not collected. Train blanks are not corrected for these reagent blanks. Sample results, by the process of subtracting train blank results, are corrected for contributions from these reagents.

(3) Filter reagent blanks analyzed for elements had unexplained outlying results in several cases. Duplicate Pallflex 102 mm filter reagent blanks were analyzed. Results for one of these reagent blanks were as expected with element concentrations equivalent to or significantly below sample results. The second Pallflex 102 mm filter reagent blank had extremely high concentrations of aluminum, potassium, and sodium which were considered outliers and not considered in blank corrections. Likewise in the analysis of triplicate Pallflex 86 mm filter reagent blanks, outlying results were obtained for aluminum and sodium in one blank and for potassium in a second blank. Again, these outlying results were not included in reagent blank corrections.

(4) The probe rinses from the high volume samples (N-5A-HVS-731-1, -2) were both labelled as -1 in submitting these samples to the subcontractor laboratory for element analysis. The analytical results for the two rinse samples provided no information to distinguish which sample was associated with soot blowing

and which with normal operations. The assignment of the samples as -1 or -2 was therefore arbitrary in determining the total element concentration (filter plus rinse) for N-5A-HVS-731-1 and -2.

(5) Problems with Si and B determinations of Method 29 samples by CTE. Boric acid was used to complex excess hydrofluoric acid after microwave digestion by CTE. Hydrofluoric acid may also react with glassware or the glass mixing chamber of the ICP analyzer, and may interfere with silicon results. Thus CTE has not reported Si and B results for some samples.

(6) The Method 29 filter was analyzed separately from the combined acetone/acid probe rinses for ICP and GFAA elements. This deviation was required to allow evaluation of the particle size distribution of elements in gas emissions.

F-2. Ammonia/Cyanide Protocols

Samples were analyzed for ammonia and cyanide according to the procedures stated in the QAPP.

F-3. Analytical Protocol for Anions

Summary of Method for Anion Analysis by Ion Chromatography

Anions of interest are separated and measured using a Dionex DX300 ion chromatography system comprised of a guard column, separator column, MicroMembrane suppressor, and conductivity detector. The separator column selectively separates ions based upon their affinity for an ion-exchange resin. The suppressor converts the eluted ions to acids which are then measured by a conductivity meter. Identification of the ions is made by their retention time on the column. Quantification is done by comparing peak height or area responses to those of calibration standards.

Deviations from Method 26A

(1) The analysis of EPA Performance Evaluation Samples (WP029) was used instead of EPA "Audit Samples" designated in Section 7.7.1 of Method 26A.

There is no effect on results because of this deviation from Method 26A. The acceptable range for either must be analytically achieved to assure method accuracy. The target values are documented by the EPA and the analysis results are recorded in the project laboratory record book.

(2) Calibration standards were prepared in deionized water instead of 0.1 N H_2SO_4 as stated in Section 5.2 of Method 26A.

As the majority of the analyses required dilution in deionized water to conform to the analytical range of the detector, deionized water was the appropriate solvent for the calibration standards. There should be no adverse effect on results from this alteration.

Deviations from Method 300.0

(1) The instrument calibration is verified approximately each hour of operation with the analysis of an Instrument Calibration Verifier (ICV) which has a tolerance of 20 percent from the known value. Section 9.4 of Method 300.0 states that the tolerance should be 10 percent. Although 10 percent is achievable precision (see RPDs of duplicates), ICV's require 20 percent because they are analyzed around the clock where temperature changes contribute to a small amount of instrumental drift above 10 percent.

Deviations from the QAPP

(1) The Custody During Lab Analysis (5.1.3.3) section states that quality control samples will be documented in a bound lab record book and assigned an LRB number. The ion chromatography lab uses a sample log for all incoming samples from which a unique 4-digit number is assigned. Copies of logged samples will be entered into a bound LRB. The chain-of-custody-form copies will serve as a record of the personnel involved and the times involved in sample-handling transactions.

(2) Data Quality Objectives (Table 5-4) should state that a standard reference material (EPA WP029) will be used as an accuracy determiner when the matrix spike is not applicable, i.e., the spiked sample is unmeasurable because of column and/or detector overload or because of matrix dilution necessary for linear range detection.

(3) The target values for the WP029 samples were achieved with each calibrated sample run except one. The result of WP29 chloride for Niles, Run #3, Solids, was 176 ppm. The acceptable range is 143-171 ppm. The oversight

was discovered too late to be corrected. Considering the fact that all of the other QC analyses for this sample run and specifically those surrounding this analysis were within control limits, the run was not invalidated.

F-4. Analytical Protocol for VOC

F-4.1 VOST Samples

Analysis of VOST sorbent traps for VOC was conducted as described in the QAPP, according to the provisions of SW-846 Method 5041, using thermal desorption GC/MS. Each sampled pair of VOST traps was placed in a heated desorption unit and purged with organic-free nitrogen or helium. The purge gas flow transferred VOC desorbed from the VOST traps to a cold trap for focussing. Heating of the cold trap released collected VOC in a small volume onto the inlet of the GC column. The VOC were then determined by temperature programmed chromatography with detection by low resolution mass spectrometry. Internal standards were used to quantify the VOC. The one deviation from plan was that hexane was not determined in VOST samples.

F-4.2 Canister Samples

Canister samples were analyzed with a gas chromatograph equipped with a mass spectrometric detector. Upon receipt, the initial pressure of each can was recorded and the can was filled with zero air to facilitate sample extraction. The initial and final pressures were used to determine the dilution correction factor. Since acidic gases have been shown to strip the analytical column of bonded liquid phase within a short time period sampled air from the canister was first directed through a sodium bicarbonate trap to reduce the content of acidic gases. The use of alkaline water was originally specified in the Analytical Management Plan but was shown prior to the field study to partly remove several of the target compounds when challenged with the 41 component calibration mixture. The effluent from the sodium bicarbonate trap was then directed to an adsorbent trap (Carbopak B/ Carbosieve S-III) to preconcentrate the target VOC species. A six port valve and thermal desorption step were used to inject the adsorbed material onto the analytical column. The column was temperature programmed from -50 to 200°C to resolve the VOC. Selective ion monitoring was used to quantify the target species. However, sufficient acidic gases were still present in the injected sample that prohibited the operation of the mass spectrometer until 11 minutes into the run. As a result, the first six species on the 41 component target list were not analyzed. A method detection level of 0.5 ppb was achieved with a sample volume of 60 cc.

F-4.3 Liquid VOC Samples

Volatile organic compounds (VOC) in liquid samples were analyzed by Zande Environmental Laboratories using purge and trap gas chromatography/mass spectrometry. EPA SW846 Method 8240 was followed for the analysis of these samples. All samples were initially analyzed within 14 days of receipt at the laboratory.

Calibration curves were generated and the appropriate Calibration Check Compounds (CCC) and System Performance Compounds (SPCC) were within the limits stated in Method 8240. The system was initially tuned with 4-bromofluorobenzene prior to analysis of the initial calibration curve. An attempt to tune the system every 12 hours of operation was made, but the 12 hour window was exceeded by 10 minutes in one instance and 20 minutes in another. A couple of tunes also failed to meet the abundance ratio criteria found in Method 8240. Continuing calibration standards were analyzed every twelve hours and in all instances but two met the continuing calibration criteria required by Method 8240. There were no target analytes present in any of the samples.

F-5. Analytical Protocol for PAH/SVOC

F-5.1 Gas and Solid Samples

The MM5 samples were prepared according to the Niles Analytical Plan. The MM5 filter and probe rinse filter were spiked with known amounts of d_{12}-chrysene and d_{12}-benzo(k)fluoranthene before Soxhlet extraction. If dioxin/furan analysis was required for the sample, known amounts of $^{13}C_{12}$-labelled dioxin/furan internal standards were also spiked onto the sample. The filters were then extracted with dichloromethane (DCM) for 18 hours. Note that in the Niles QAPP the extraction time is indicated as 16 hours, but the actual extraction time for all the samples was 18 hours. The DCM extract was combined with the filtrate from the probe rinse and concentrated by Kuderna-Danish (K-D) evaporation. If dioxin/furan analysis was required, the combined extract was split into two equal portions: one portion for SVOC analysis and one portion for dioxin/furan analysis. Cyclone samples collected at Locations 4a and 5a were spiked with perdeuterated PAH and extracted with DCM for 18 hours. The DCM extracts were concentrated to 1 mL by K-D evaporation for silica gel column chromatography.

The XAD-2 samples were spiked with perdeuterated PAH and/or ^{13}C-labelled dioxin/furan and extracted with DCM. The condensate was adjusted to pH 7 and extracted with DCM according to the QAPP. The XAD-2 extract was combined with the module rinse and condensate, and concentrated to 1 mL for silica gel column chromatography.

Aliquots of the solid process samples were spiked with perdeuterated PAH and extracted with DCM for 18 hours. The DCM extracts were concentrated to 1 mL for silica gel column chromatography.

The DCM extract was solvent exchanged into hexane (C_6) and applied to a silica gel column. The column was packed with 5 percent water deactivated silica gel with C_6. Three elution solvents, C_6, C_6/DCM (50/50), and methanol were applied to the column. The C_6/DCM fractions were concentrated to 1 mL with K-D evaporation and further concentrated to 100 μL with nitrogen evaporation for GC/MS analysis. Some of the C_6/DCM fractions of XAD-2 extracts were diluted to 1 mL or more to minimize sample matrix effects for GC/MS analysis. The methanol fractions were concentrated to 1 mL, evaporated almost to dryness, and solvent exchanged into 1 mL of DCM, however these fractions were not analyzed. The only target analyte expected in this fraction is quinoline for which data are not provided.

A Finnigan TSQ-45 GC/MS/MS operated in GC/MS mode equipped with an INCOS 2300 data system was employed. Helium was the GC carrier gas and a 70 ev electron beam was used. The MS was operated in the selected ion monitoring mode. Ion peaks monitored by MS are the molecular ions and characteristic fragment ions of target analytes. Identification of the target analytes was based on the correct molecular ion, correct fragment ions, and the correct retention time relative to the internal standard. Quantification of each target analyte followed the method described in the Niles QAPP.

F-5.2 Liquid SVOC Samples

Semivolatile organic compounds (SVOC) in liquid samples were extracted and analyzed by Battelle using liquid/liquid extraction, and analysis by gas chromatography/mass spectrometry. EPA SW846 Method 3560 and 8270 was followed for the analysis of these samples. All samples were initially extracted within 7 days of receipt at the laboratory and the extracts analyzed within 40 days.

One liter aliquots of each sample were fortified with the appropriate surrogate compounds to monitor extraction efficiency, serially extracted three times with methylene chloride, concentrated to 1 mL, fortified with internal standards and analyzed on an HP 5970 MSD. Every sample with the exception of blanks and spiked blanks formed emulsions during the base/neutral extraction. Due to the formation of emulsions, during the base/neutral extraction, each 60 mL aliquot of extract was collected in a centrifuge bottle, centrifuged, the organic removed and the remainder added back to the separatory funnel prior to the next addition of solvent. Once the samples were acidified, emulsions did not form and the samples were processed without centrifugation. No problems were encountered in the concentration step.

Calibration curves were generated and the appropriate Calibration Check Compounds (CCC) and System Performance Compounds (SPCC) were within the limits stated in Method 8270.

The system was initially tuned with decafluorotriphenylphosphine prior to analysis of the initial calibration curve. The system was also tuned every twelve hours of operation and met the required ion abundances. Continuing calibration standards were analyzed every twelve hours and in all instances met the continuing calibration criteria required by Method 8270 for CCCs and SPCCs. Method 8270 allows for 30 percent RSD on CCCs and this criteria was used. The QAPP incorrectly stated 25 percent RSD.

F-6. Analytical Protocol for Dioxins/Furans

Samples of the vapor phase and particulates from the MM5 sampling train were extracted for dioxin/furan analysis with the same procedures used for PAH/SVOC gas and solid samples. The front half of the MM5 train, including the probe rinse and particulate filter, were prepared and analyzed for dioxins/furans in the solid phase and the back half of the MM5 train, including XAD-2 resin, module rinse and condensate, were prepared and analyzed for dioxins/furans in the vapor phase as outlined in the QAPP.

The solid phase sample was prepared by filtering the probe rinse, combining the probe rinse filter and the particulate filter in a Soxhlet extractor, spiking with $^{13}C_{12}$-labeled dioxin/furan standards and extracting with methylene chloride. The extract was combined with the probe rinse filtrate and the combined solution was split into two equal portions, one of which was further processed for dioxin/furan analysis. The vapor phase sample was prepared by Soxhlet extracting with methylene chloride the XAD-2 resin spiked with $^{13}C_{12}$-labeled dioxin/furan standards. The XAD-2 extract was combined with the module rinse and condensate extracts. The combined solution was split into two equal portions, one of which was further processed for dioxin/furan analysis.

Both the solid and vapor phase samples were processed through dioxin/furan cleanup procedures which included spiking the extracts with 2,3,7,8-TCDD-$^{37}Cl_4$ cleanup standard, washing with acidic and basic solutions, and processing through acid/base silica, alumina, and carbon cleanup columns. The clean extracts were concentrated and spiked with 1,2,3,4-TCDD-$^{13}C_{12}$ and 1,2,3,7,8,9-HxCDD-$^{13}C_{12}$ recovery standards. Samples were then analyzed for dioxins/furans by gas chromatography/ high resolution mass spectrometry.

The sample preparation procedures outlined above and described in the QAPP differ somewhat from the preparation procedure detailed in EPA Method 23. A major difference is that the sampling trains were prepared to obtain two sample fractions, one representative of the solid phase and one representative of the vapor phase. Other differences include:

- The Soxhlet equipment was pre-extracted and samples extracted with methylene chloride rather than toluene. Methylene chloride was the preferred extraction solvent for obtaining volatile PAH analytes. As stated in the QAPP, both dioxin/furan and PAH data were obtained by extracting one sample and splitting the extract into two portions, one for dioxin/furan specific cleanup and one for

PAH specific cleanup. To insure recovery of the volatile PAHs while not affecting the efficiency of extracting dioxins/furans, methylene chloride was used as the extraction solvent.

- Samples were Soxhlet extracted for 18 hours rather than 16 as specified in Method 23 and the QAPP. The additional extraction time should not have impacted the analytical results.

- The calibration and spiking solutions used were at concentrations recommended by EPA Method 1613. Method 1613 solution concentrations vary slightly from Method 23 and also include additional $^{13}C_{12}$-labeled internal standards. The additional labeled internal standards provide better accuracy in identifying and quantifying analytes.

- Extract cleanup involved two additional steps which are recommended cleanup procedures in EPA Method 1613. First, the addition of 2,3,7,8-TCDD-$^{37}Cl_4$ as a recovery standard to each extract prior to any cleanup was used to evaluate the recovery of analytes through the cleanup procedures. Second, the addition of acid/base washing the extract prior to column cleanups. The acid/base wash is a routine step in both EPA Methods 8290 and 1613.

- Cleanup columns included acid/base silica, alumina, and AX21/celite as required in Method 23; however, amounts of column packing material and elution solvents were similar to those listed in EPA Method 1613 and varied slightly from Method 23 in some instances.

- The GC oven temperature program for separating analytes on a DB-5 column follows Method 1613, which varies somewhat from Method 23, but provides adequate separation of all analytes of interest.

- No second column confirmation of 2,3,7,8-TCDF on a DB-225 column was performed. The DB-5 column does not separate 2,3,7,8-TCDF from other TCDF isomers. As a result, values reported for 2,3,7,8-TCDF could include contributions from coeluting, non-2,3,7,8 isomers.

- No surrogate standards listed in Method 23 were added to the sampling trains before collecting field samples; therefore, the sampling train collection efficiency was not determined.

- Routine continuing calibration response factors for 2,3,4,7,8-PeCDF-$^{13}C_{12}$ and 1,2,3,4,6,7,8-HpCDF-$^{13}C_{12}$ were slightly outside the $\pm$ 30 percent limit from the initial calibration at the end of the analysis day on 10/11/93 and 10/12/93, respectively. Because of the very low level of analytes found in the samples, and because only two response factors out of a total of 33 native and recovery response factors were out of limits, the initial calibration was not repeated.

F-7. Analytical Protocol for Aldehydes

Gas samples (DNPH impinger solutions) and liquid process samples were analyzed for formaldehyde, acetaldehyde, acrolein, and propionaldehyde using high performance liquid chromatography with ultraviolet detection (HPLC/UV). Prior to the collection of the gas aldehydes, the DNPH reagent for the impinger samples was prepared by mixing 0.06 g of purified DNPH crystals per 250 mL of acetonitrile. Fifty (50) μL of sulfuric acid was also added to each 250 mL of DNPH reagent.

After the gas samples had been collected and prior to analysis, the volume of DNPH impinger solution collected from each impinger was measured with a graduated cylinder. Next, a 4-mL aliquot from each sample was transferred to a 4-mL HPLC sample vial with a septa-seal top. The HPLC vials were used as the permanent storage vessel for the impinger samples. These HPLC vials were refrigerated before and after analysis.

For liquid samples (both process liquid samples and condensed water samples from the gas sampling trains), all samples were reacted with DNPH just prior to analysis. An aliquot of 2 mL of each liquid sample and 2 mL of DNPH reagent were mixed in a 4-mL HPLC sample vial with septa-seal top. The HPLC vials were used as the permanent storage vessel for the liquid samples. The liquid-DNPH solutions were allowed to react for at least 3 hours prior to analysis. This reaction time is necessary to assure that all of the aldehyde species present in the liquid will be converted to carbonyl-DNPH derivatives. After the waiting period, the samples were analyzed. For the liquid samples, standards were prepared by adding the neat aldehydes to HPLC water at concentrations above and below those found in the actual samples. The standard water samples were reacted with the DNPH in the same manner as the actual samples.

For the process liquid samples, additional sample preparation steps had to be implemented because of the potential for suspended solids in the samples. Prior to reaction with the DNPH solution, the process liquid samples were filtered through a 0.22 μm filter.

After the liquid samples were reacted with the DNPH, a white precipitate settled out in a few of the samples. To protect the HPLC system, the liquid above the precipitate was decanted off and placed into a new HPLC vial. It was this liquid that was analyzed on the samples in which precipitation occurred.

All of the samples were analyzed with a Waters HPLC system. An acetonitrile/H_2O mixture (65/35) serves as the mobile phase. Column flow is 0.8 mL/min. Typically, the injection volume used for aldehyde samples was 30 μL.

F-8. Analytical Protocol for Radionuclides

Radiological analysis of both the gas (filter) samples and the solid samples was performed by the International Technology (IT) Corporation's Oak Ridge, Tennessee laboratory using a gamma scan method. The samples were prepared for gamma spectrometry using that laboratory's standard operating procedure OR-7003, Revision 0. Then the radioactivity counts were obtained using IT-Oak Ridge standard operating procedure OR-7212, Revision 0.

During the analysis procedures the following reports were prepared:

(1) Gamma Spectroscopic Analysis Parameters
(2) Summary of Positively Identified Nuclides
(3) Summary of Unidentified Nuclides
(4) Peak Search Report (Gross)
(5) Peak Search Report (Net)
(6) Summary of Nuclide Activity
(7) Nuclide Line Activity Report
(8) Full Combined Activity - MDA Report
(9) Unidentified Energy Lines Report
(10) Total Uranium Analysis Parameters and Summary
(11) Full Combined Uranium Activity - MDA Report

For each sample the analysis results were summarized by reporting the activity in pico Curies per gram for the following isotopes as was called for in the QAPP:

Pb-210	Pb-211
Pb-212	Th-229
Ra-226	Th-230
Ra-228	U-234
Th-234	U-235

APPENDIX G

UNCERTAINTY ANALYSIS

UNCERTAINTY ANALYSIS

An error analysis was conducted to provide an estimate of the uncertainty of the reported values for average emission factors. Emission factors on three days are reported in Section 6.2, along with the arithmetic average, $\bar{E}$. This Appendix describes the calculations done to estimate the total uncertainties in emission factors, shown as TU in the tables in Section 6.2. Daily emission factors were calculated by:

$$E_i = \frac{2.205 * g * (s+v)}{(HHV * cf)} \qquad \text{(G-1)}$$

where

E_i = daily emission factor, lb/10^{12} Btu

g = daily flue gas flow rate, Ncm/hr

s = daily solid phase concentration of substance in flue gas, μg/Ncm

v = daily vapor phase concentration of substance in flue gas, μg/Ncm

HHV = daily higher heating value of feed coal, Btu/lb

cf = coal feed rate, klb/hr

A goal of this project was to determine a representative value for E, the average emission factor for a substance from the power plant. The reported value of $\bar{E}$ is an average from only three days of sampling. Daily variation in operation of the power plant contributes to uncertainty in the estimation of the long term average emission rates of substances.

G-1. Identification of Sources of Error

Two types of errors must be considered (ANSI/ASME PTC 19.1-1985, "Measurement Uncertainty", available from the American Society of Mechanical Engineers): random errors (or precision errors) and bias.

Three factors contribute to precision errors or variability in the reported daily emission factors. First, plant operating conditions change from day to day. Second, variability in collecting samples leads to errors in determining the five parameters in equation G-1 that are used to calculate the estimate of E_i. Third, variability in analyzing the collected samples for s, v, and HHV leads to errors in estimating E_i.

Bias in determining E_i can result from systematic errors in determining any of the five parameters in equation G-1. Bias errors are assumed to be constant throughout the measurement process. They can be significant, known and accounted for in calibrations; insignificant, known, and ignored in the uncertainty analysis; or estimated and included in the uncertainty analysis. The bias, when included in an uncertainty analysis, is estimated as a upper limit of the bias error.

G-2. Procedures for Estimating Uncertainty

The error analysis for this project was designed to provide uncertainty intervals around the reported average emission factors of the form

$$\textit{Emission factor } (lb/10^{12}\ Btu) = \bar{E} \pm (U^2 + B^2)^{1/2} \tag{G-2}$$

where

$\bar{E}$ = arithmetic average of the daily emission factors E_i

U = an approximate 95% confidence bound accounting for random errors

B = possible bias due to systematic errors.

Precision Errors

The 95% confidence bounds were calculated by

$$U = \frac{t * S}{\sqrt{3}}$$

where

t = 4.303, the upper 97.5 percentile of Student's t distribution with two degrees of freedom

S = standard deviation of the three daily emission factors.

Thus,

$$U = 2.48*S.$$

The resulting confidence level is approximately 95 percent. This assumes that the distribution of daily emission factors for each substance approximates a normal distribution.

Battelle evaluated whether or not to use propagation of error methods, such as those described in the ANSI/ASME document cited above, to determine the statistical uncertainty of the average emission factors. Propagation methods are often used to establish the uncertainty of a function of several measured input parameters. Battelle believes that the approach described above is preferred over propagation of error methods because the objective of this error analysis is to estimate the uncertainty of the average of independent determinations of daily emission factors. Computing the standard deviation of the E_i accounts for the three sources of variability cited above: day-to-day variations in plant operations, sampling error, and measurement error. The propagation of errors method is an approximate solution that will produce similar results, provided that the correlations among the input parameters are taken into account. For example, one would expect a high degree of correlation between the measured solid and vapor phase concentrations on each day and between the daily coal feed rates and flue gas flow rates.

Bias

The potential bias on E due to systematic errors in any of the five measured parameters in equation G-1 was calculated by

$$B = (\Sigma B_j^2)^{1/2} \qquad \text{(G-3)}$$

where $B_j = dE_i/dp_j * \beta_j$ is the resulting bias in E_i caused by a systematic error of β_j in measuring parameter p_j ($j=1$-5 for g, s, v, HHV, and cf). These errors could not be specifically identified or confirmed; thus no correction was applied to the measured parameters. Battelle's estimates of the values of β_j are described below.

__Flue gas flow rate__. Determination of the flue gas flow rate, g, was assigned an upper limit of twelve percent for bias error. The bias for the gas flow measurement was estimated by comparing measured gas flow rates to flow rates calculated from the coal feed rate and the oxygen content at the various sampling points. The average difference between the "measured" and calculated flue gas flow rates was 14 percent. This value was assigned to the parameter β_1.

Solid phase concentrations. Solid phase concentrations, s, were calculated by dividing the quantity of a substance determined in the laboratory analysis of a sample by the flue gas volume associated with that sample. The amount of sample collected from the flue gas stream approximates the actual concentration. Potential bias in the quantity of collected material is summarized in Table G-1.

Sources of analytical bias (Quality Assurance for Chemical Measurements; Taylor, John Keenan; Lewis Publishers, Inc., Chelsea, Michigan, 1987) are listed in Table G-2 along with the estimate of the magnitude of the bias associated with each source. The estimates shown in Table G-2 were derived as follows:

Inefficiency Losses - Results for organic analyses are corrected for extraction recoveries. A bias of 2 percent is estimated for inorganic analyses based on matrix spike and SRM recovery results.

Calibration - For most organic and inorganic analytes, routine calibration results were required to be within ± 25 percent of initial calibration. Battelle's estimate of the bias in calibration is 5 percent.

Interference Resolution - The estimate of bias is zero because interferences are typically corrected for in organic and inorganic analyses or data are flagged as being affected by interference.

Contamination Gains - Data are corrected for contamination gains derived from field sampling, sample handling, and sample shipping by subtracting train blank results from sample data; therefore, the bias estimate is zero.

Instrumental Shifts - Instrumental shifts are considered to be corrected for by calibration bias; therefore the estimate is zero.

Matrix Effects - Matrix effects are evaluated by use of matrix spike samples. The estimate is zero because no consistent bias was detected in analysis of either inorganic or organic matrix spike samples.

Theoretical - Battelle's extensive experience with the inorganic and organic analyses conducted on this program has not detected any consistent bias based on theoretical effects; therefore the estimate is zero.

Operator Bias - Many of the analyses were conducted by different operators and no consistent bias was detected; therefore the estimate is zero.

Tolerance Adjustments - Based on Battelle's laboratory analysis experience, consistent bias with tolerance adjustments is nonexistent; therefore the estimate is zero.

Uncorrected Blank - Most sample results are corrected for laboratory method blanks and reagent blanks (where applicable) or blank results are negligible. Therefore the estimated bias from uncorrected blanks is zero.

Based upon these estimates, a bias error of five percent for organic solid phase determinations was estimated. Seven percent was estimated for inorganic solid phase determinations.

Considering both sampling and analysis together, the estimates of β_j for solid substances were computed as the square root of the sum of the squares of the individual bias estimates (see Table G-4).

Vapor phase concentrations. Vapor phase concentrations, v, were calculated by dividing the quantity of a substance determined in the laboratory analysis of a sample by the flue gas volume associated with that sample. The amount of sample collected from the flue gas stream approximates the actual concentration. Potential bias in the quantity of collected material is summarized in Table G-3.

Sources of analytical bias and associated bias estimates for vapor phase samples are the same are those listed in Table G-2 for solid phase samples except for the bias associated with the inefficiency losses for inorganic analyses. This bias is estimated to be 1 percent rather than 2 percent because the difficulty with preparing liquid phase samples for inorganic analysis is typically less than that for solid phase samples.

Combining the errors for sampling and analysis, Battelle estimated the β_j for vapor substances as shown in Table G-5.

Higher heating value of coal. The bias for the coal heating value determination was estimated at 2 percent. This estimate is based on the fact that the coal heating value is determined by a well-proven ASTM procedure by laboratories doing many samples daily. Additionally, utilities keep careful watch over their boiler efficiency and heat rate values. As the heating value is a major input to boiler efficiency and heat rate calculations, a bias as large as 2 percent would be obvious. Hence, a 2 percent bias estimate was assigned to the heating value determinations.

Coal feed rate. The bias for the coal feed rate measurement for the Niles Station Boiler No. 2 was estimated at 2 percent. This estimate was based on the fact that utilities, in general, keep careful watch over their fuel consumption and boiler efficiency. (The cost of fuel is typically 40 to 50 percent of the cost of generating electricity and, thus, is of major importance.) A bias as large as 2 percent in the fuel feed rate would be very obvious to the plant operators and action would be taken to correct any problem. Review of operations at Niles Station led to assignment of a value of 2 percent for β_5.

Summary. The estimated upper limits for bias terms β_j are listed in Table G-6. Because of the uncertainty in estimating values for the β_j themselves, a decision was made to combine the values for β_2 and β_3 into one term. Therefore the values of $\beta_{2/3}$ were assigned as follows: elements - 7 percent, anions - 7 percent, radionuclides - 9 percent, particulate matter - 8 percent, SVOC - 7 percent, dioxins/furans - 7 percent, ammonia/cyanide - 6 percent, VOC - 8 percent, and aldehydes - 6 percent. Together with calculations of precision error, these terms were used to calculate the uncertainty intervals shown in tables of emission factors in Section 6.2.

G-3. Example Calculation

The following example calculation applies to calculating the uncertainty in the average emission factor for mercury.

Daily emission factors were calculated using Equation G-1:

$$E_1 = \frac{2.205 * 318{,}960 * 27.4}{12{,}269 * 91.5} = 17.1\ lb/10^{12} Btu$$

$$E_2 = \frac{2.205 * 305{,}580 * 21.2}{12{,}108 * 94.2} = 12.5$$

$$E_3 = \frac{2.205 * 307{,}200 * 23.2}{11{,}892 * 96.7} = 13.7$$

The parameters used to calculate E_1, for July 27, 1993, are found as follows:

Parameter	Value	Where Found
g	318,960 Ncm/hr	Table 2-2 as 5,316 Ncm/min
s+v	27.4 μg/Ncm	Table 5-4
HHV	12,269 Btu/lb	Table 5-58
cf	91.5 klb/hr	Table 2-4

The average value $\bar{E}$ was calculated as

$$\bar{E} = \frac{(17.1 + 12.5 + 13.7)}{3} = 14.4\ lb/10^{12}\ Btu$$

The standard deviation, S, of the daily emission factors was calculated as

$$S = \sqrt{\frac{1}{(N-1)} \sum_{i=1}^{N} (E_i - \bar{E})^2}$$

$$= \sqrt{\frac{1}{2}[(17.1 - 14.4)^2 + (12.5 - 14.4)^2 + (13.7 - 14.4)^2]} = 2.39\ lb/10^{12}\ Btu$$

The parameter U was calculated as

$$U = 2.48 * S = 2.48 * 2.39 = 5.93\ lb/10^{12}\ Btu$$

The bias parameter B was calculated using Equation G-3. The B_j components were calculated as follows:

$$B_1 = \frac{dE}{dg} \beta_1$$

$$B_{2/3} = \frac{dE}{d(s+v)} \beta_{2/3}$$ (j=2, s and j=3, v were combined)

$$B_4 = \frac{dE}{dHHV} \beta_4$$

$$B_5 = \frac{dE}{dcf} \beta_5$$

where E, g, (s+v), HHV, and cf are each the average value.

Now,

$$\frac{dE}{dg} = \frac{2.205 * (s+v)}{HHV * cf}, \quad j=1$$

$$\frac{dE}{d(s+v)} = \frac{2.205 * g}{HHV * cf}, \quad j=2/3$$

$$\frac{dE}{dHHV} = \frac{-2.205 * g * (s+v)}{(HHV)^2 * cf}, \quad j=4$$

$$\frac{dE}{dcf} = \frac{-2.205 * g * (s+v)}{HHV * cf^2}, \quad j=5$$

From Table G-6, the β_j are:

$$\beta_1 = 14\% \ of\ g$$

$$\beta_{2/3} = 7\% \ of\ (s+v)$$ (see text on page G-7)

$$\beta_4 = 2\% \ of\ HHV$$

$$\beta_5 = 2\% \ of\ cf$$

The term B_1 was calculated as follows:

$$\frac{dE}{dg} = \frac{2.205 * 23.9}{12{,}089.67 * 94.13} = 4.63 \times 10^{-5}\ (lb/10^{12}\ Btu)/(Ncm/hr)$$

where (s+v) = average of daily values (Table 5-4)

= (27.4 + 21.2 + 23.2)/3 = 23.9 μg/Ncm

HHV = average of coal heating values

= (12,269 + 12,108 + 11,892)/3 = 12,089.67 Btu/lb

cf = average of coal feed rate (Table 2-4)

= (91.5 + 94.2 + 96.7)/3 = 94.13 lb/hr

therefore,

$$B_1 = 4.63 \times 10^{-5} * 0.14 * 310{,}580 = 2.02\ lb/10^{12}\ Btu$$

where g = average of daily values (Table 2-2)

= (5,316 + 5,093 + 5,120) * 60/3 = 310,580 Ncm/hr

Using the values above, the other components of bias were calculated in a similar manner, i.e.,

$$B_{2/3} = \frac{2.205 \times 310{,}580}{12{,}089.67 * 94.13} * 0.07 * 23.9 = 1.01\ lb/10^{12}\ Btu$$

$$B_4 = \frac{-2.205 * 310{,}580 * 23.9}{(12{,}089.67)^2 * 94.13} * 0.02 * 12{,}089.67 = -0.288 \; lb/10^{12} \; Btu$$

and

$$B_5 = \frac{-2.205 * 310{,}580 * 23.9}{12{,}089.67 * (94.13)^2} * 0.02 * 94.13 = -0.288 \; lb/10^{12} \; Btu$$

Then,

$$B = (2.02^2 + 1.01^2 + (-0.288)^2 + (-0.288)^2)^{1/2}$$

$$B = 2.29 \; lb/10^{12} \; Btu$$

Finally, the total uncertainty was calculated as

$$U = (5.93^2 + 2.29^2)^{1/2} = 6.36 \; lb/10^{12} \; Btu$$

TABLE G-1. BIAS ESTIMATES FOR FLUE GAS SAMPLING OF SOLID SUBSTANCES

Analyte Class	Estimated Bias (percent)	Source of Bias; Documentation
Elements Anions SVOC Dioxins/Furans Radionuclides Particulate Matter	5	Departure from isokinetic sampling; value is based on sampling data that show maximum departure of about 5 percent from isokinetic conditions. The bias for collection of solid phase material was assumed to be equal in magnitude to the departure from isokinetic conditions.
Elements Anions SVOC Dioxins/Furans Radionuclides Particulate Matter	2	Flow measurement error; required by Method regulations and maintained so by gas meter calibrations. Also consistent with RTI audits of Battelle's gas meters.
Elements SVOC Dioxins/Furans Particulate Matter	0	Loss of particulate matter in probe; value of zero results from recovery of particulate matter in probe wash.
Anions Radionuclides	5	Loss of particulate matter in probe; value is an estimate based on use of short probe, with no probe rinse. Consistent with losses of particles observed in long probe and flexible line.

TABLE G-2. BIAS ESTIMATES FOR LABORATORY ANALYSIS

Source of Bias[a]	Estimated Bias (percent) Organic[b]	Inorganic[c]
Inefficiency Losses	0	2 (solid) 1 (vapor)
Calibration	5	5
Interference Resolution	0	0
Contamination Gains	0	0
Instrumental Shifts	0	0
Matrix Effects	0	0
Theoretical	0	0
Operator Bias	0	0
Tolerance Adjustments	0	0
Uncorrected Blank	0	0

(a) Quality Assurance for Chemical Measurements; Taylor, John Keenan; Lewis Publishers, Inc., Chelsea, Michigan, 1987.

(b) Organic analytes include SVOC, dioxins/furans, VOC, and aldehydes.

(c) Inorganic analytes include elements, anions, ammonia/cyanide, and radionuclides.

TABLE G-3. BIAS ESTIMATES FOR FLUE GAS SAMPLING OF VAPOR SUBSTANCES

Analyte Class	Bias (percent)	Source of Bias; Documentation
Elements Ammonia/Cyanide Anions VOC SVOC Dioxins/Furans Aldehydes	2	Flow measurement error; required by Method regulations and maintained so by gas meter calibrations. Also consistent with RTI audits of Battelle's gas meters.
Elements Ammonia/Cyanide Anions Aldehydes	2	Completeness of collection in impinger solutions; based on experience with similar systems, including DNPH for aldehydes.
VOC SVOC Dioxins/Furans	5	Completeness of collection on solid sorbents; based on experience with similar systems, including XAD for PAH/SVOC.
Elements SVOC Dioxins/Furans	0	Loss in probe; value of zero results from recovery of probe wash.
Ammonia/Cyanide Anions VOC Aldehydes	2	Loss in probe; value is maximum likely value given elevated temperature of probe, but no probe wash.

TABLE G-4. CALCULATION OF BIAS ERROR TERMS (β_2) FOR SOLID PHASE SAMPLES

Substance	Sampling Bias[a] Errors (percent)	Analytical Bias[a] Errors (percent)	β_2[b] (percent)
Inorganic			
Elements	5,2	5,2	8
Anions	5,2,5	5,2	9
Radionuclides	5,2,5	5,2	9
Particulate Matter	5,2	5,2	8
Organic			
SVOC	5,2	5	7
Dioxins/Furans	5,2	5	7

(a) See text for origin of individual estimates.

(b) Computed as the square root of the sum of the squared error estimates for sampling and analysis.

TABLE G-5. CALCULATION OF BIAS ERROR TERMS (β_3) FOR VAPOR PHASE SAMPLES

Substance	Sampling Bias[a] (percent)	Analytical Bias[a] (percent)	β_3[b] (percent)
Inorganic			
Elements	2,2	1,5	6
Anions	2,2,2	1,5	6
Ammonia/Cyanide	2,2,2	1,5	6
Organic			
SVOC	2,5	5	7
Dioxins/Furans	2,5	5	7
VOC	2,5,2	5	8
Aldehydes	2,2,2	5	6

(a) See text for origin of individual estimates.

(b) Computed as the square root of the sum of the squared error estimates for sampling and analysis.

TABLE G-6. ESTIMATED VALUES FOR BIAS TERMS IN THE UNCERTAINTY ANALYSIS

Parameter	Substance	Upper Limit Bias Term β_j (percent)
g		14
s	Elements	8
	Anions	9
	Radionuclides	9
	Particulate Matter	8
	SVOC	7
	Dioxins/Furans	7
v	Elements	6
	Anions	6
	Ammonia/Cyanide	6
	SVOC	7
	Dioxins/Furans	7
	VOC	8
	Aldehydes	6
HHV		2
cf		2